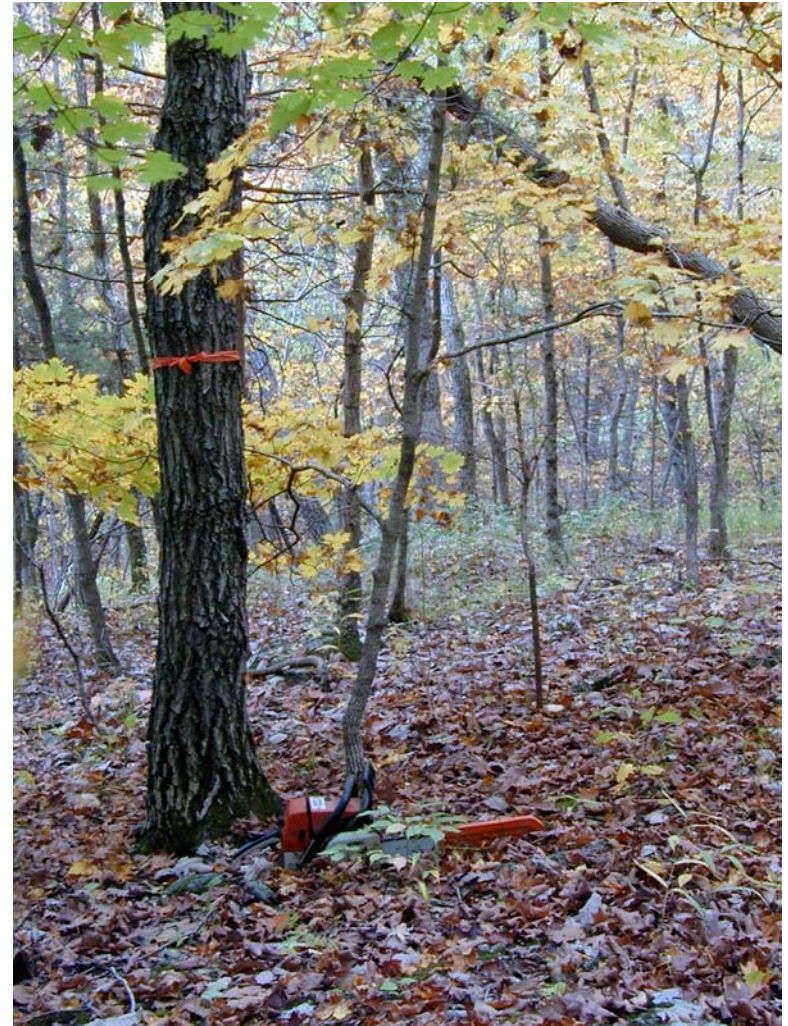


Predicting Effects

- Age
- Species
- Site
- Predisposing factors
- Associated inciting factors



Effects, so far....

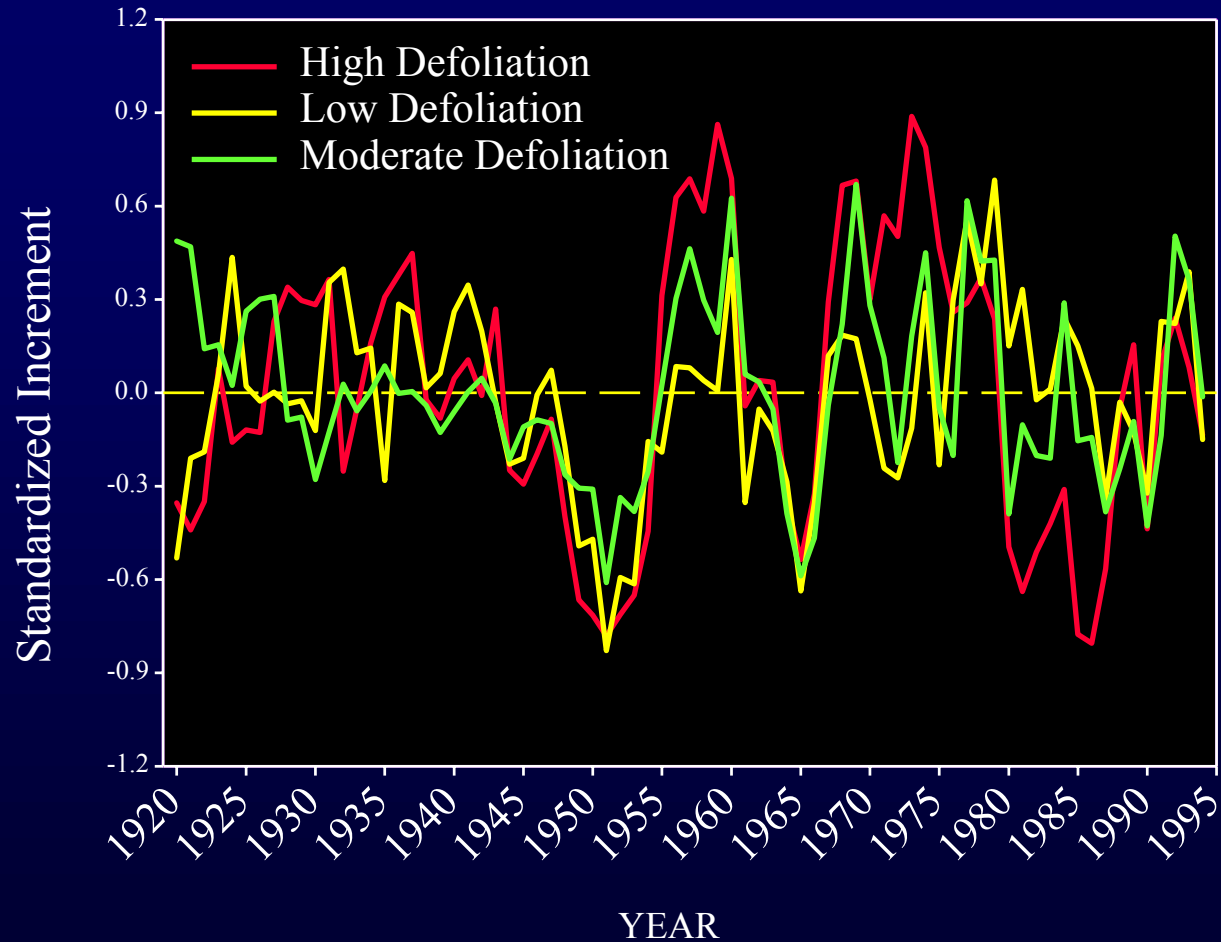


How does gypsy moth defoliation influence vegetation in eastern forests?

- Changes in competitive relationships
 - Decreased increment in hosts and secondary hosts*
 - Increased increment in non-hosts*
- Changes in species composition
 - Species loss (hosts) may occur at stand level*
 - At landscape level species loss is unlikely*
- Changes in species diversity
- Groundflora species:
 - increasing α diversity ; ? β diversity*
- Overstory species:
 - decreasing α diversity ; ? β diversity*
- Acceleration of successional trends
- Loss of dominance of oaks*
- Exacerbates oak regeneration problems
- Interaction between site conditions and disturbance history must be considered.

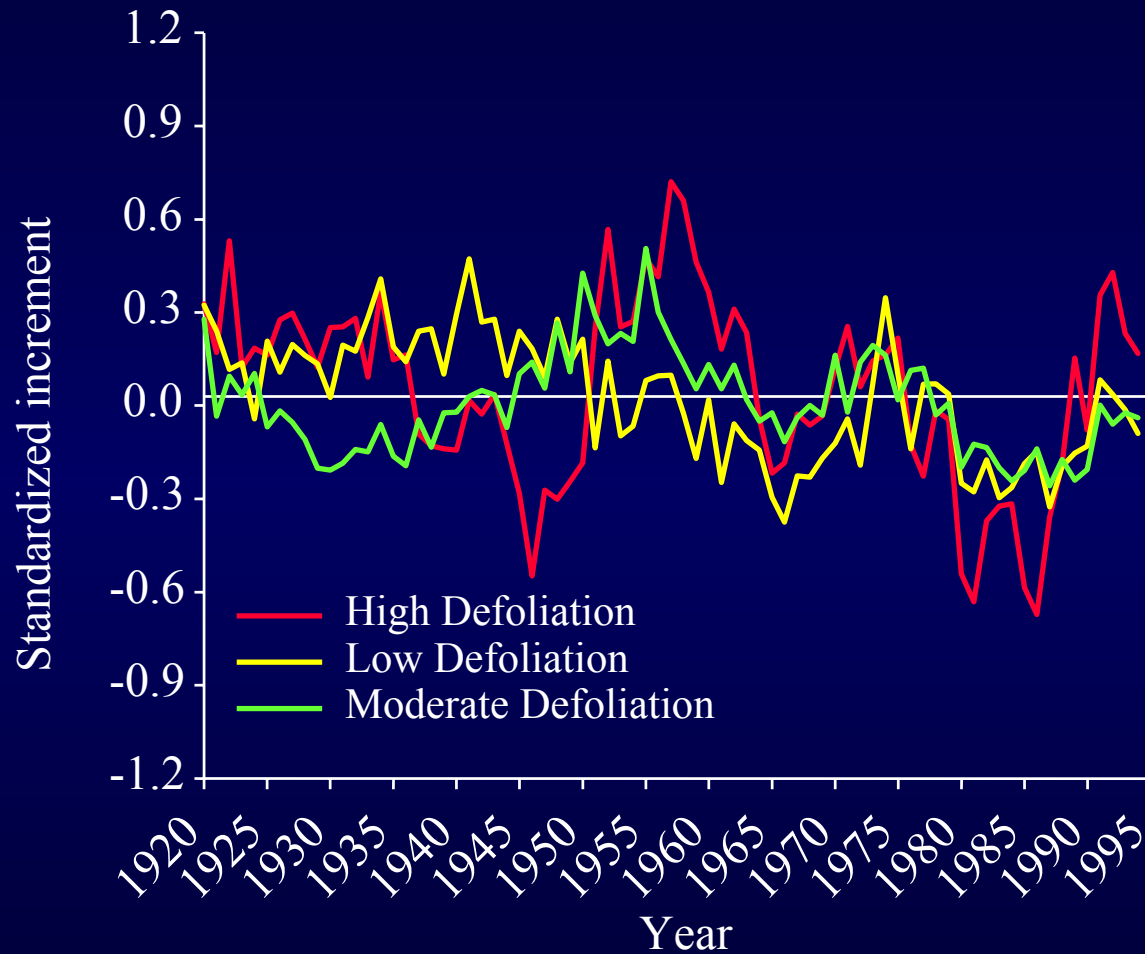
Quercus rubra

Central Pennsylvania



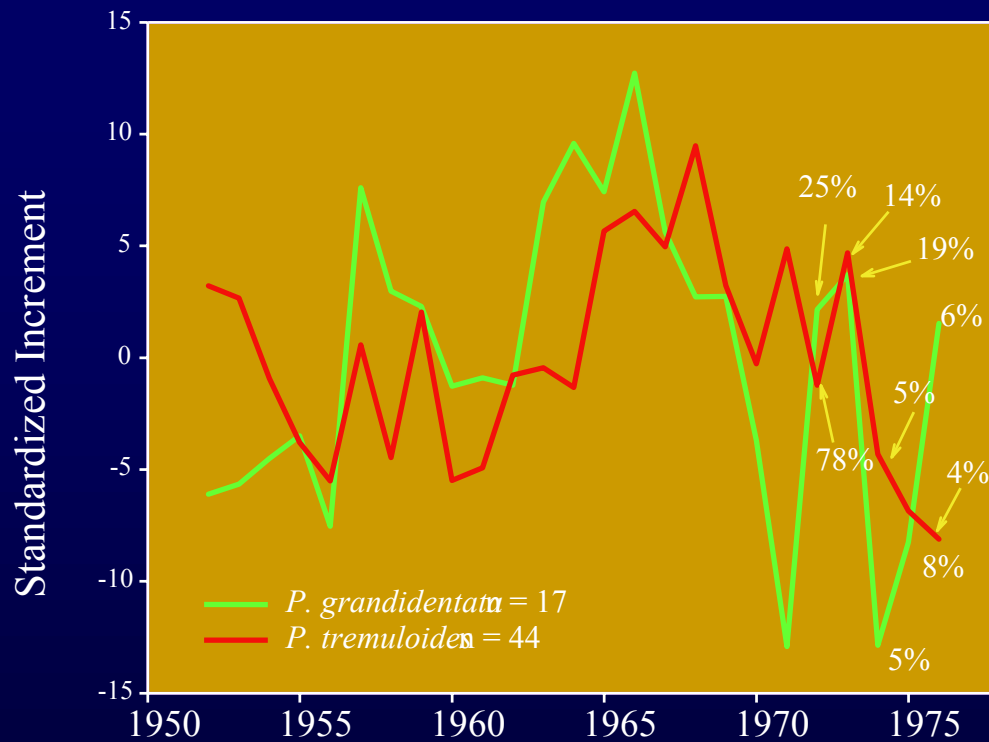
Quercus prinus

Central Pennsylvania



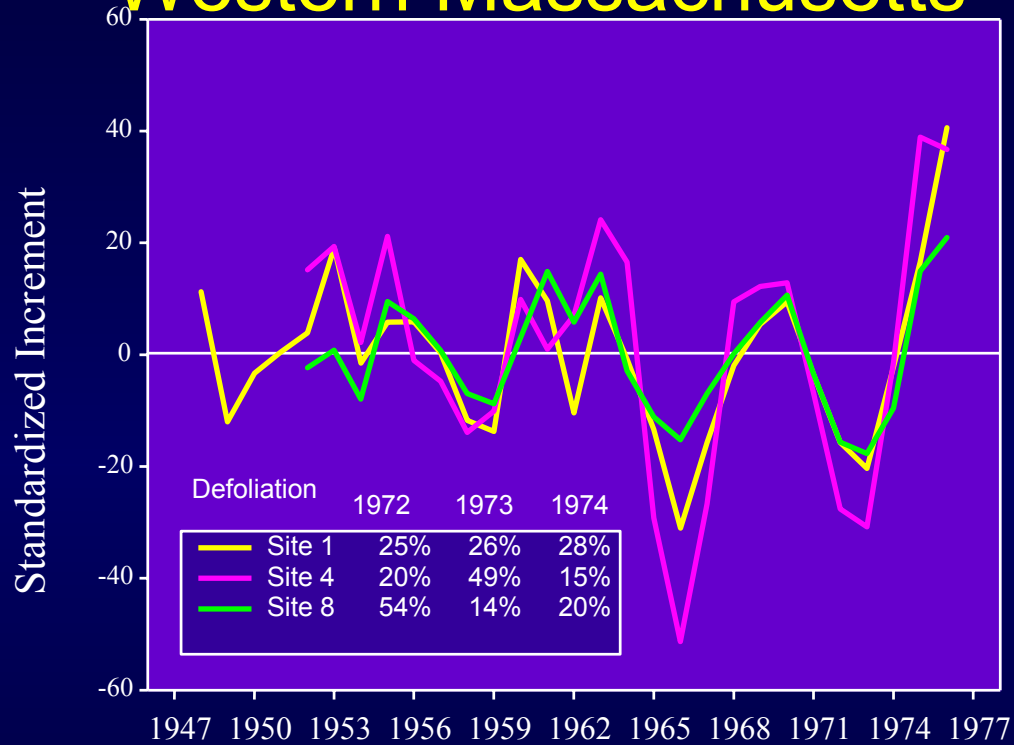
Aspen

Western Massachusetts



Quercus rubra

Western Massachusetts



Results of stepwise regression of increment on defoliation averaged across areas and sites

Host Species	n	variable	estimate	P
<i>Quercus alba</i>	23	defoliation	-1.775	0.0004
<i>Quercus coccinea</i>	19	defoliation	-2.231	0.0001
		lag1defoliation	-0.786	0.0369
<i>Quercus prinus</i>	27	defoliation	-2.381	0.0001
<i>Quercus rubra</i>	35	lag1defoliation	-2.152	0.0050
<i>Pinus rigida</i>	15	defoliation	-2.713	0.0001

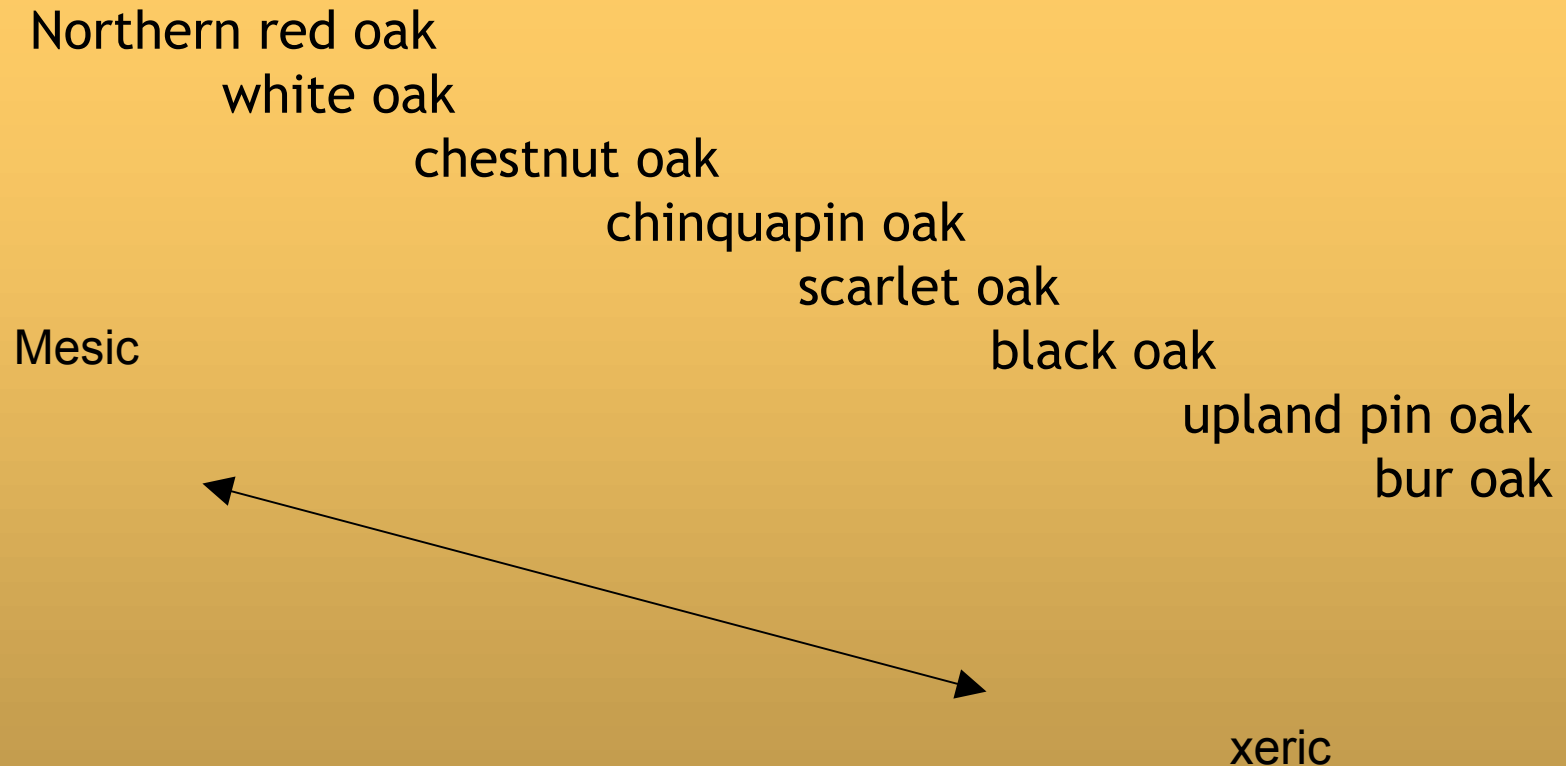
Results of stepwise regression of increment on defoliation using individual host tree species data

Species	n	Variable	Estimate	P
<i>Betula papyrifera</i>	70	none		
<i>Betula populifolia</i>	55	none		
<i>Ostrya virginiana</i>	410	none		
<i>Populus grandidentata</i>	100	none		
<i>Populus tremuloides</i>	246	lag1 defoliation	0.442	0.0081
<i>Quercus alba</i>	2065	defoliation	-0.579	0.0001
		lag1 defoliation	-0.171	0.0001
<i>Quercus coccinea</i>	915	defoliation	-0.709	0.0001
		lag1 defoliation	-0.271	0.0001
<i>Quercus prinus</i>	1300	defoliation	-0.771	0.0001
		lag1 defoliation	-0.169	0.0014
<i>Quercus rubra</i>	1700	defoliation	-0.633	0.0001
		lag1 defoliation	-0.685	0.0001
<i>Quercus velutina</i>	380	defoliation	-0.750	0.0001
		lag1 defoliation	-0.292	0.0122
<i>Tilia americana</i>	65	none		

Results of stepwise regression of increment on defoliation using individual non-host tree species data

<i>species</i>	n	variable	estimate	P
<i>Pinus rigida</i>	395	stand defoliation	-0.014	0.0001
<i>Pinus strobus</i>	793	lag stand defoliation	-0.011	0.0001
<i>Tsuga canadensis</i>	70	none		
<i>Acer rubrum</i>	1120	none		
<i>Acer saccharum</i>	295	none		
<i>Betula lenta</i>	120	none		
<i>Carya, species</i>	75	none		
<i>Carya ovata</i>	395	none		
<i>Cornus florida</i>	120	none		
<i>Fagus grandifolia</i>	230	none		
<i>Fraxinus spp.</i>	235	lag stand defoliation	0.016	0.0344
<i>Liriodendron tulipifera</i>	105	lag stand defoliation	0.014	0.0474
<i>Nyssa sylvatica</i>	105	none		
<i>Prunus serotina</i>	75	none		
<i>Sassafras albidum</i>	65	none		

Continuum of oak forests



Oak barrens, Tennessee



Gypsy moth host preferences

Favored

Oaks**	aspen	basswood	willow
apple	white birch	larch	sweetgum**
gray birch	hawthorn	witch-hazel	serviceberry

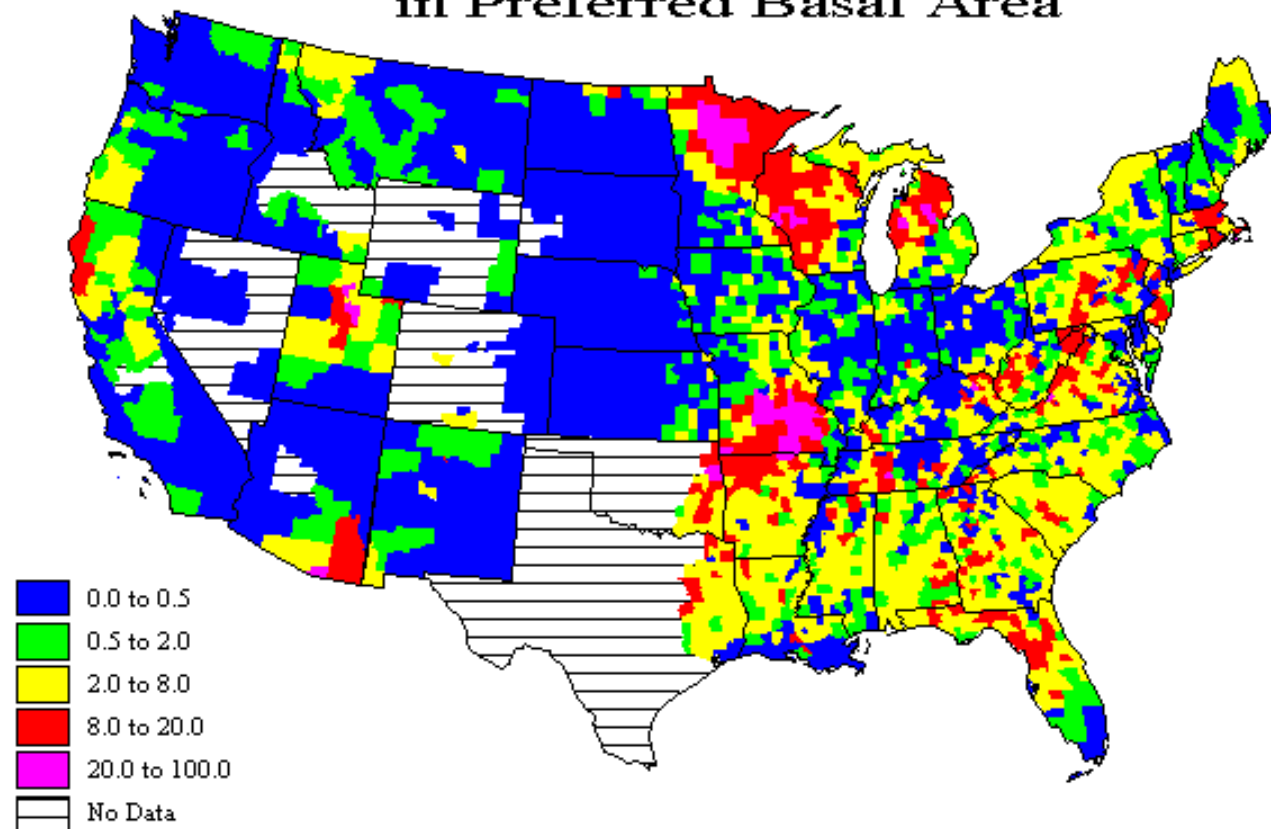
Resistant

beech	maple	cherry	pine
hemlock	spruce	chestnut	hickory
butternut	walnut	cottonwood	yellow birch

Immune

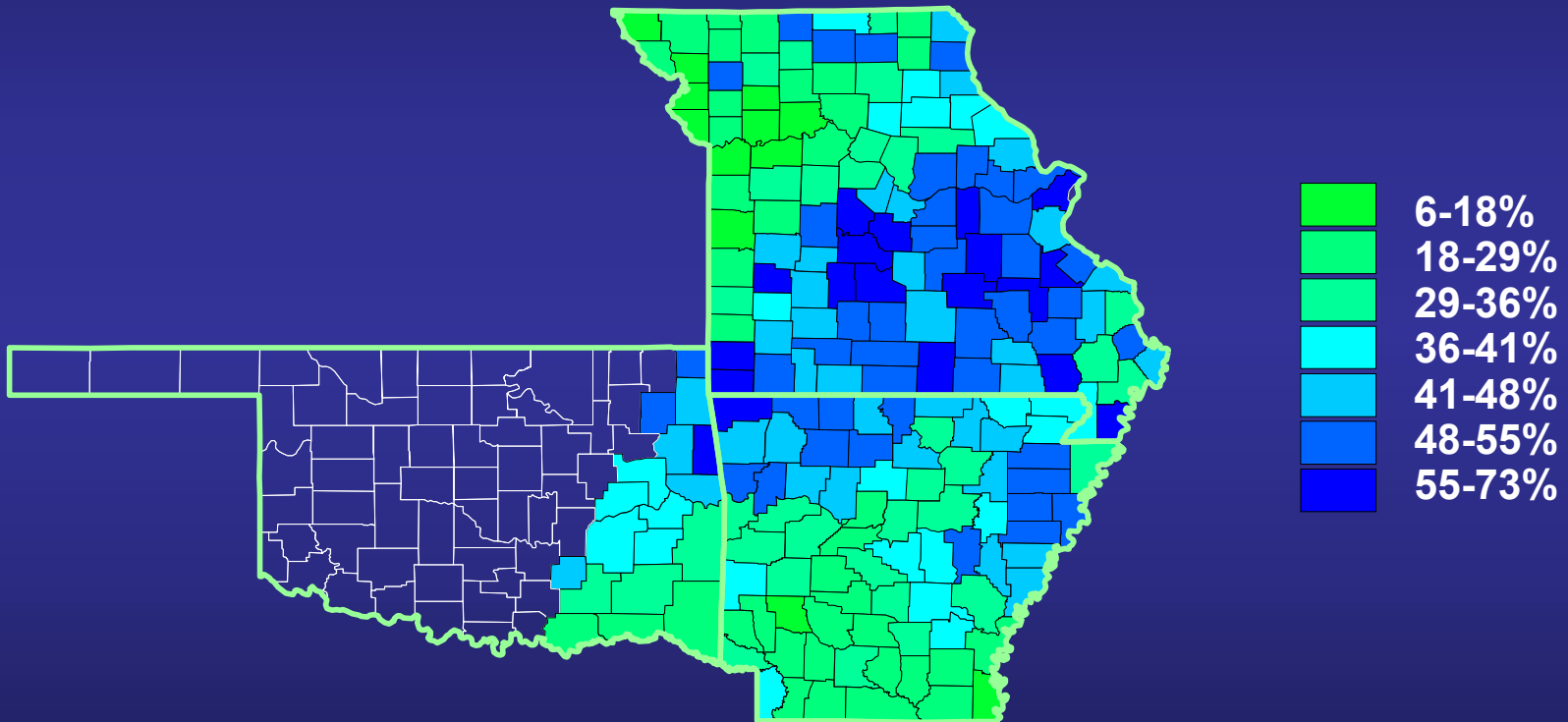
ash	cedar	locust	tulip-poplar
juniper	sycamore	balsam fir	horsechestnut
dogwood	azalea	laurel	rhododendron

Percent Land Area Above 80% in Preferred Basal Area



From: Liebhold, Gottschalk, Mason

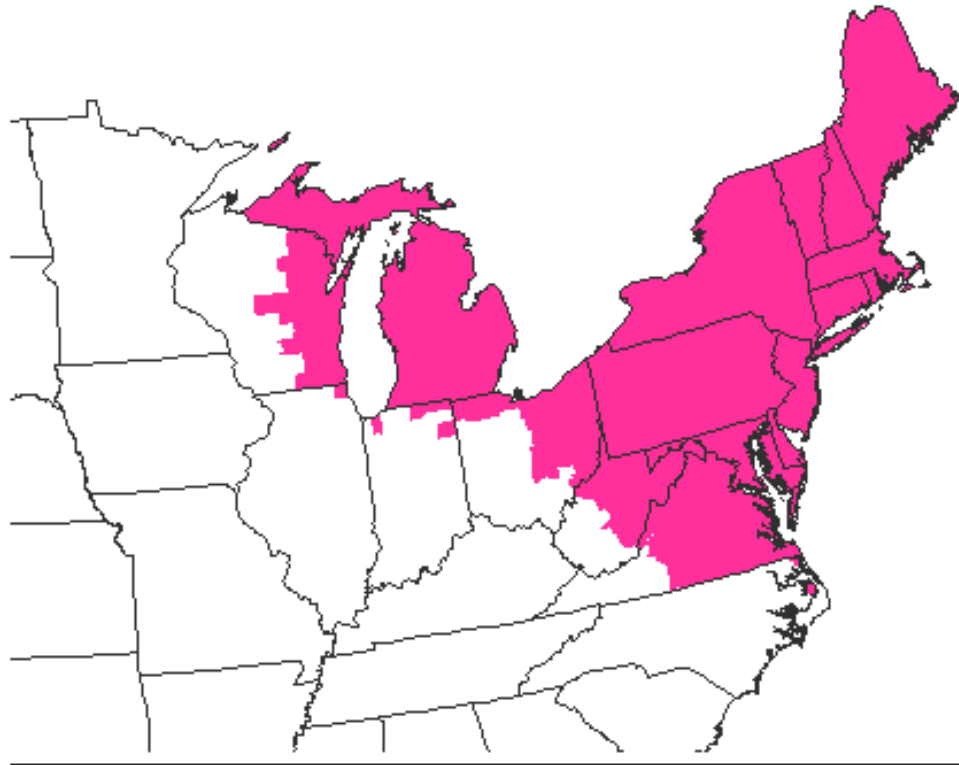
Basal Area (%) of Preferred Tree Species by county



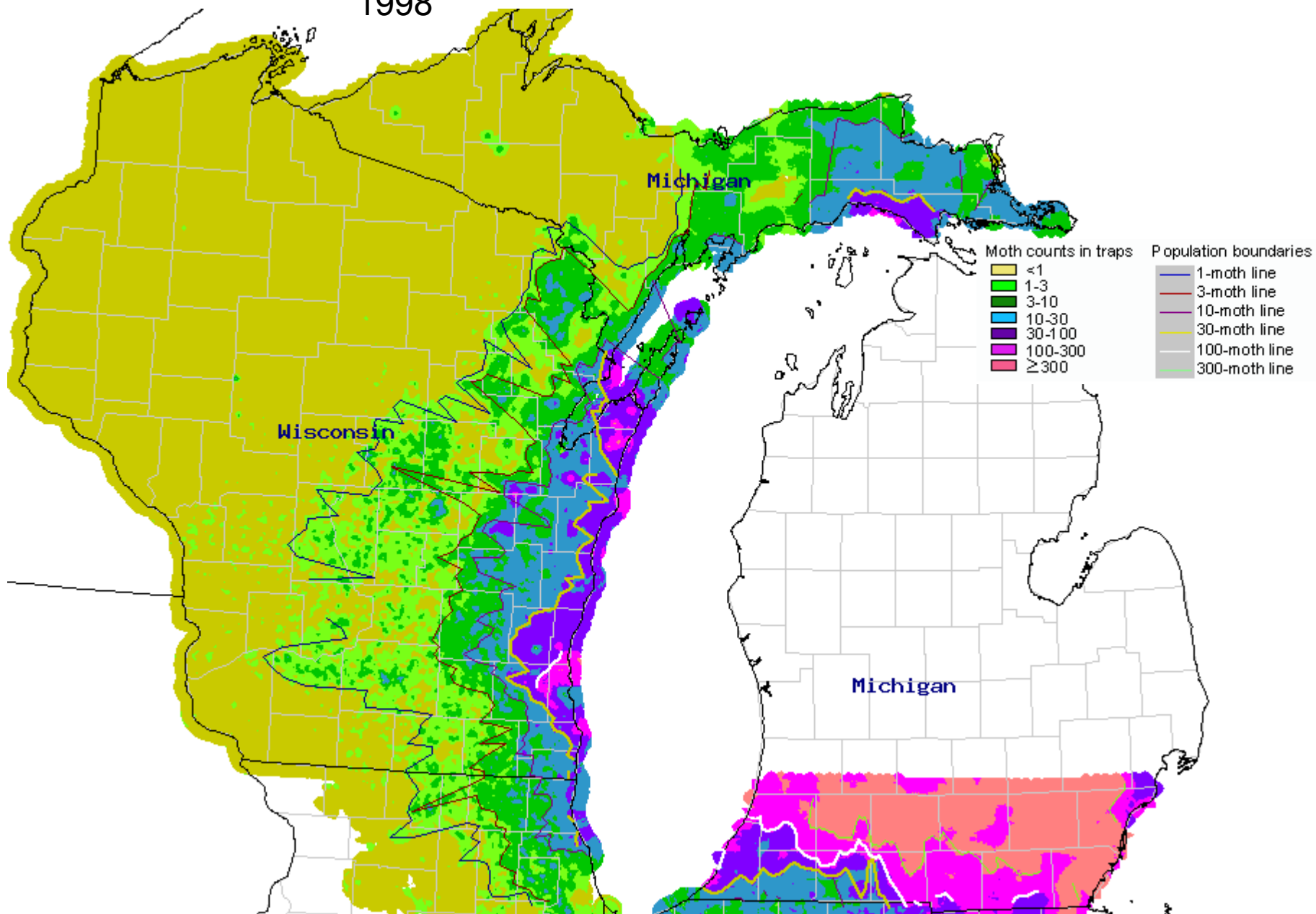




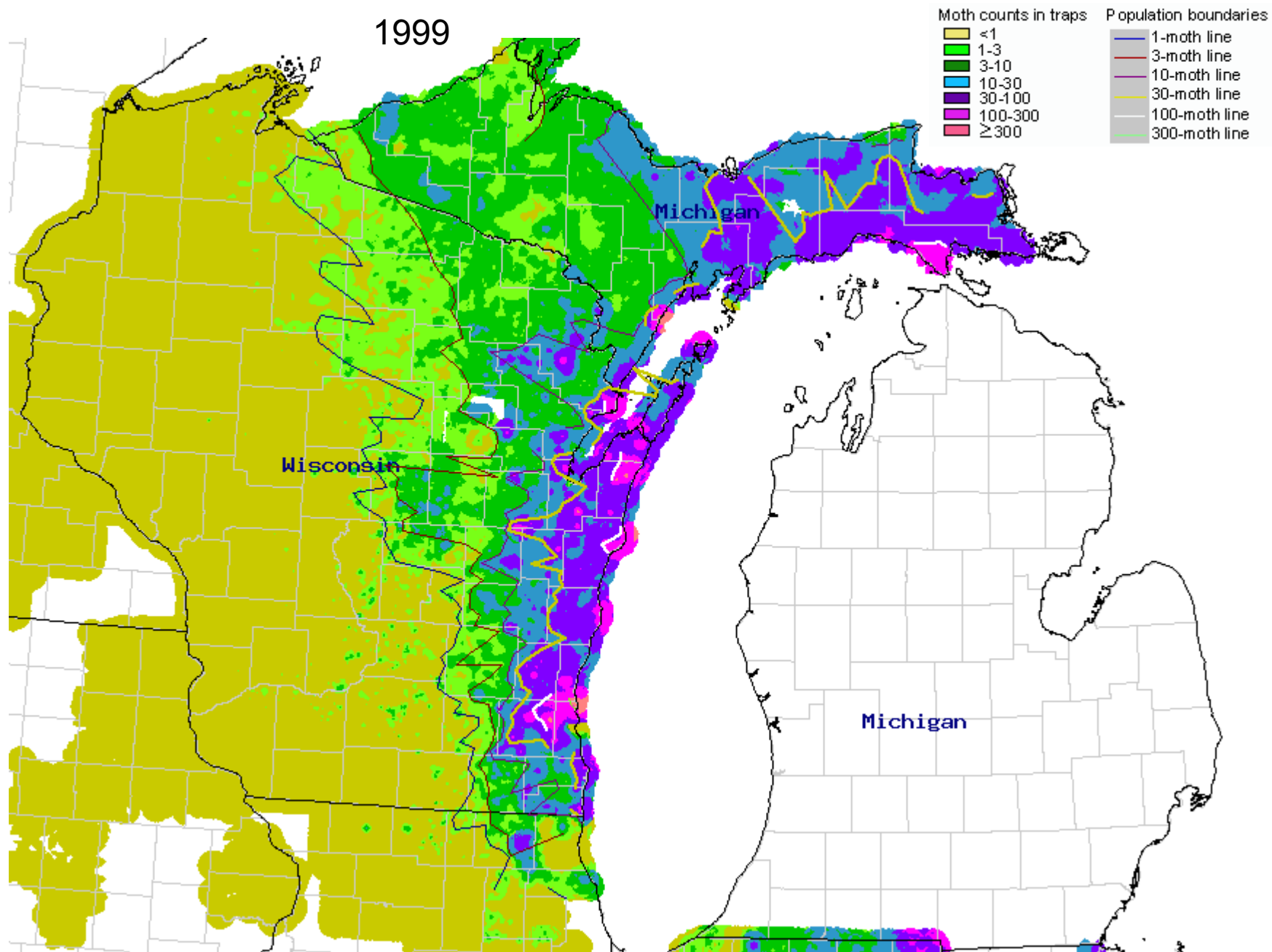
Quarantine 2003



1998



1999





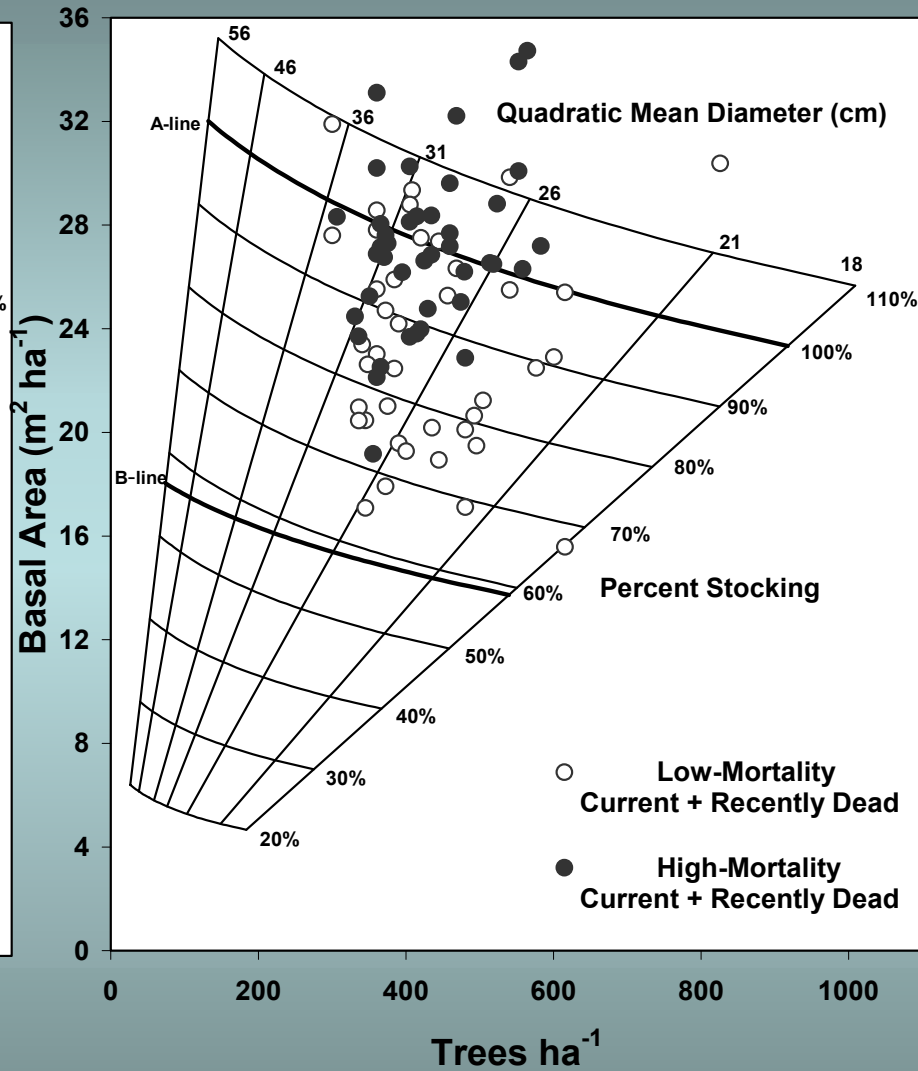
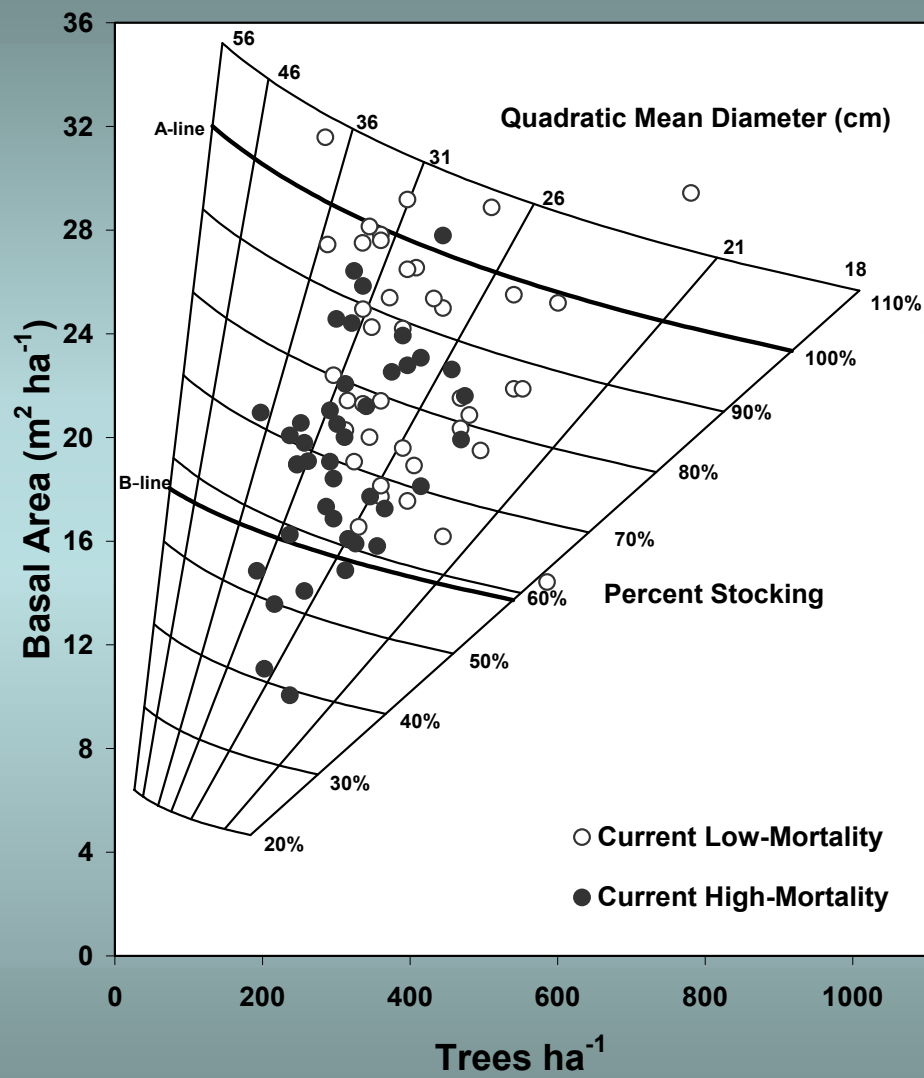
Stocking Level as a Predisposing Factors

➤ Differential mortality from decline is expressed primarily in average to densely stocked stands at a certain age.

After stand structure and stocking changes from mortality, it no longer is a factor.



The influence of stocking

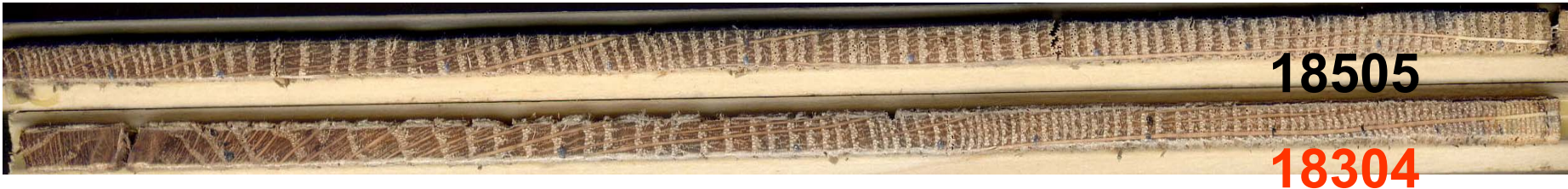
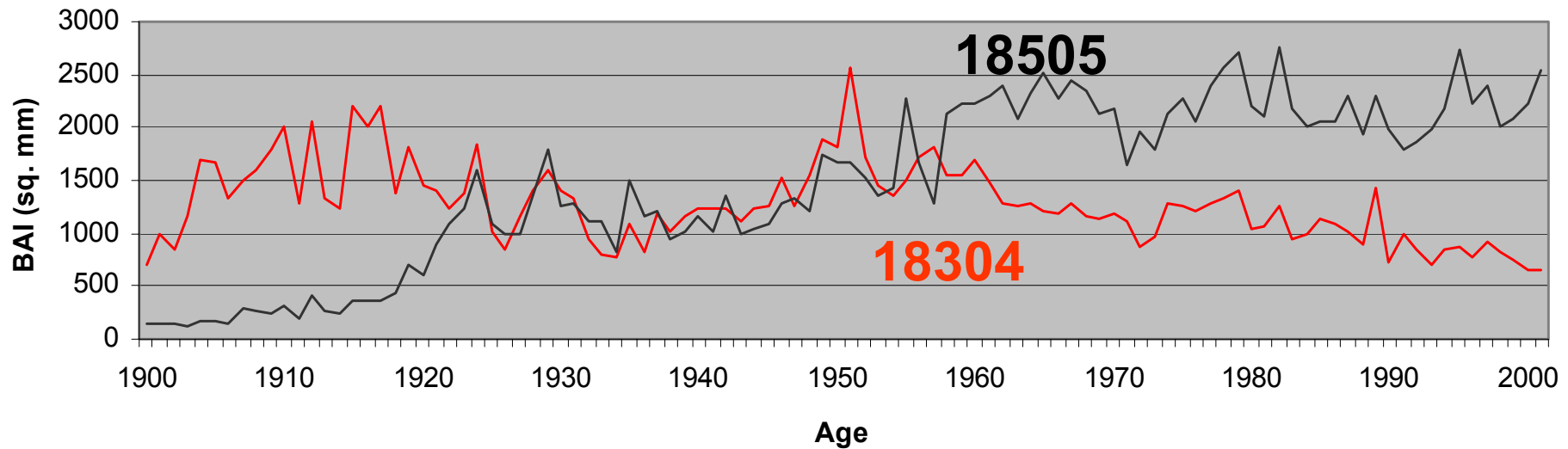




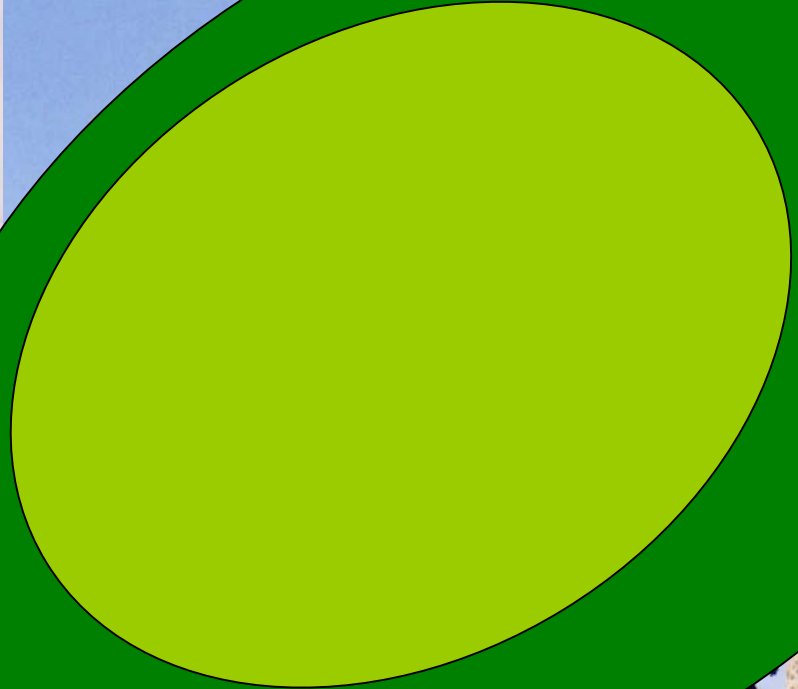
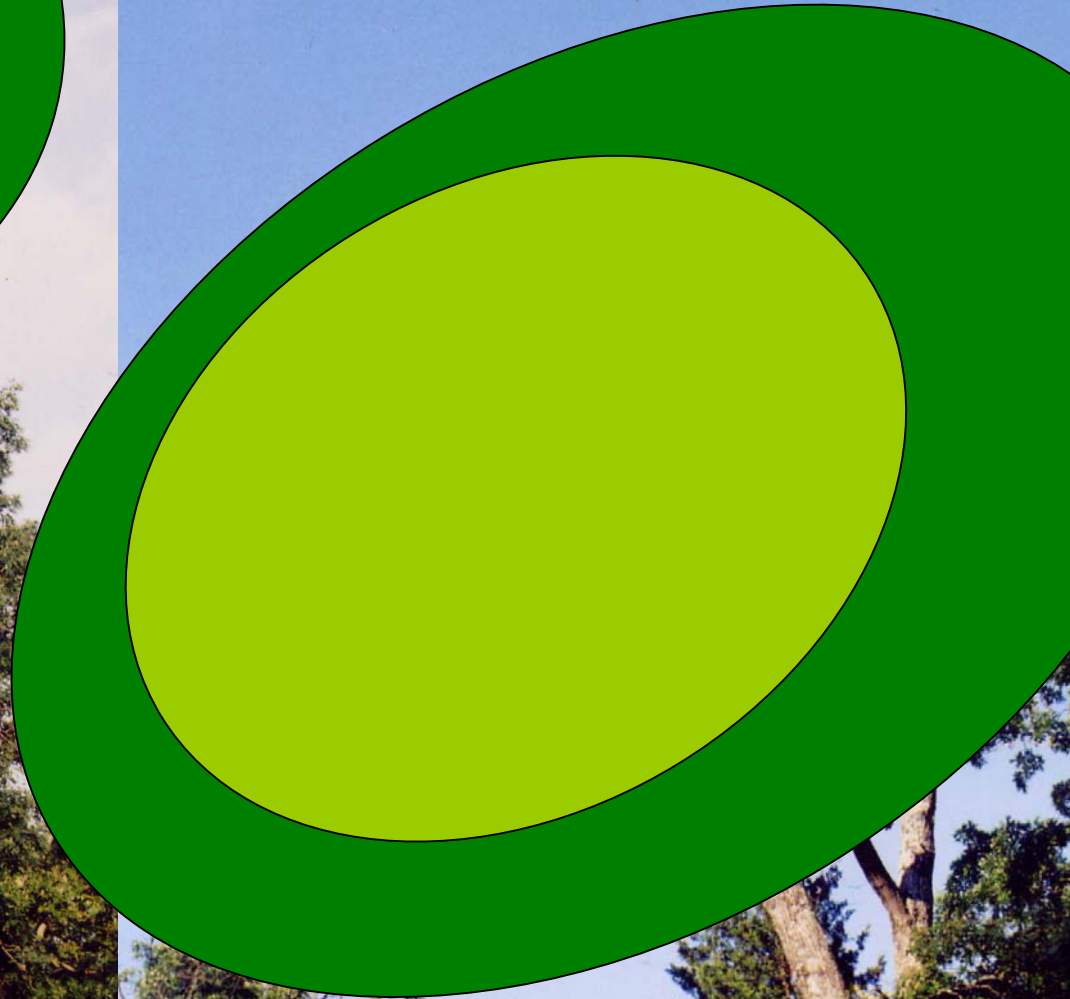


Measuring Tree Vigor

Tree Rings and Basal Area Increment

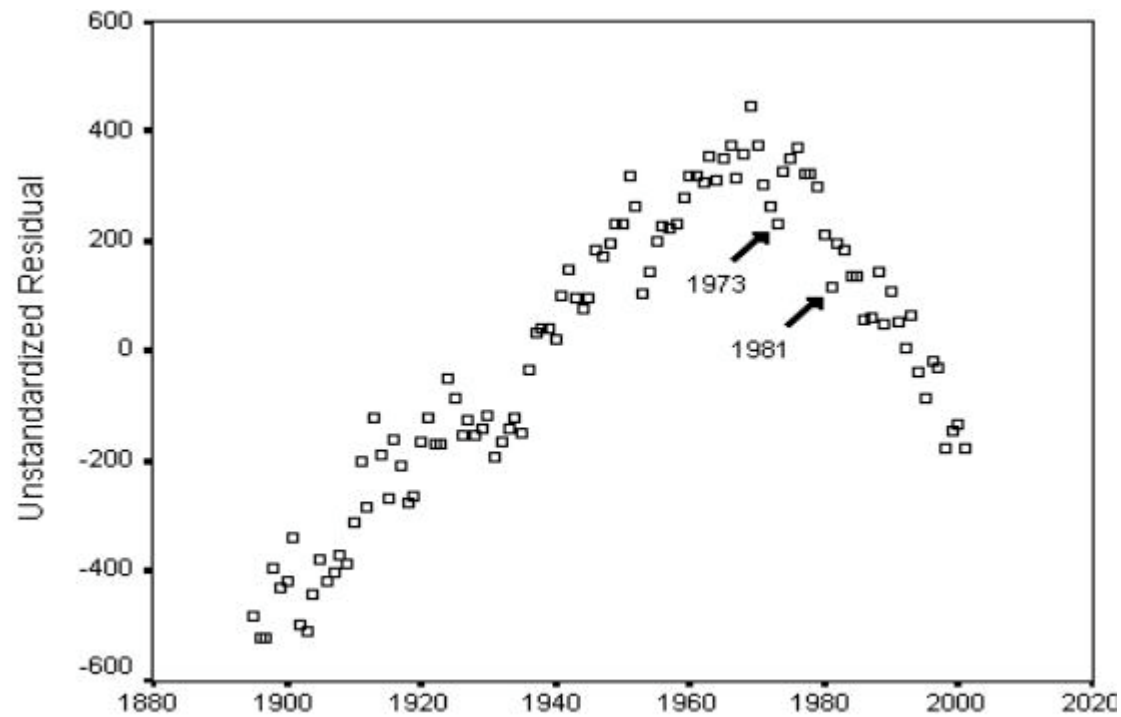


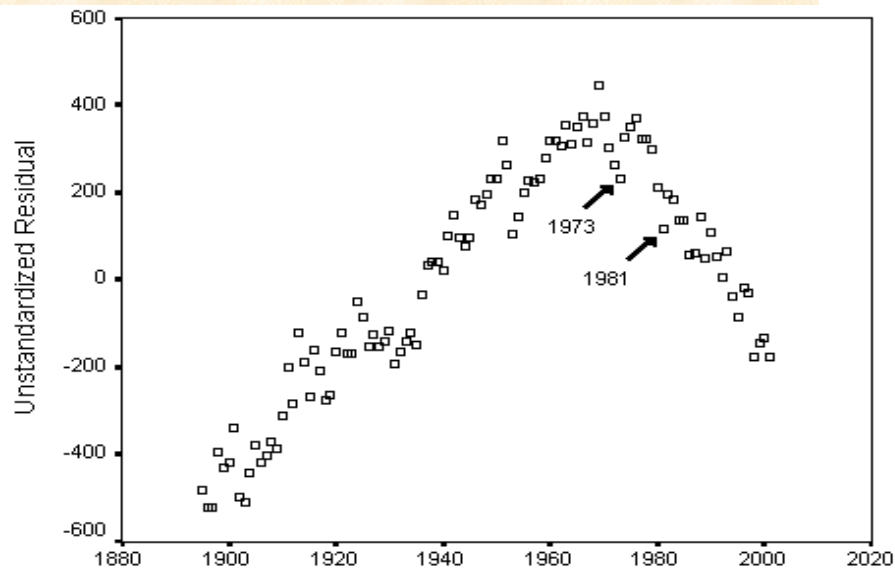
Changing architecture
Quantifying vigor



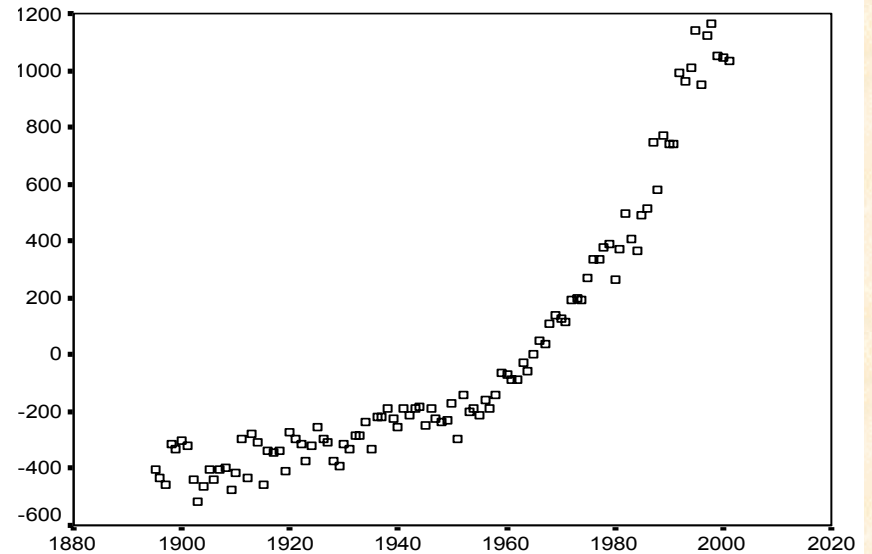


Long-term growth pattern for declining trees.



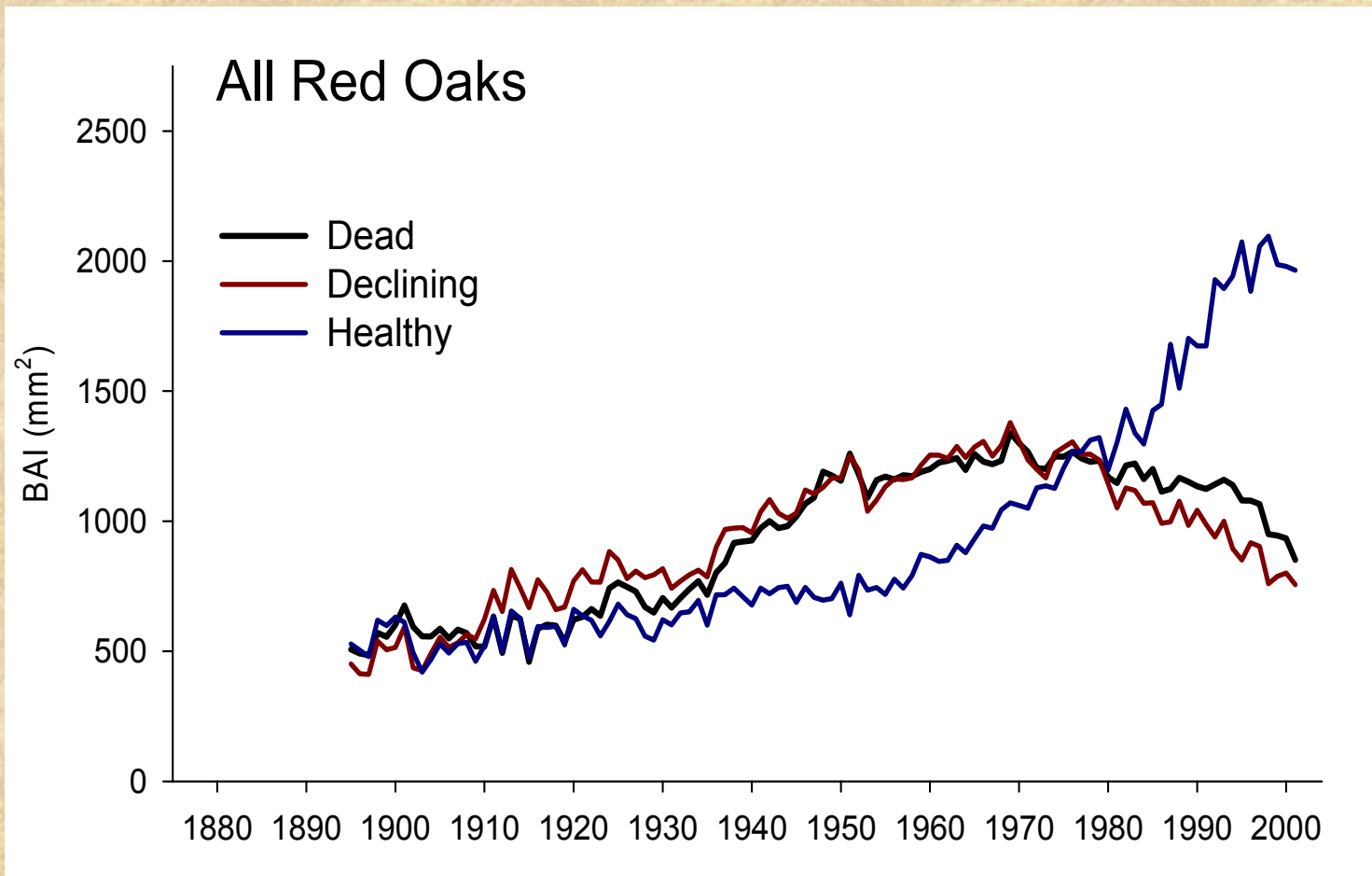


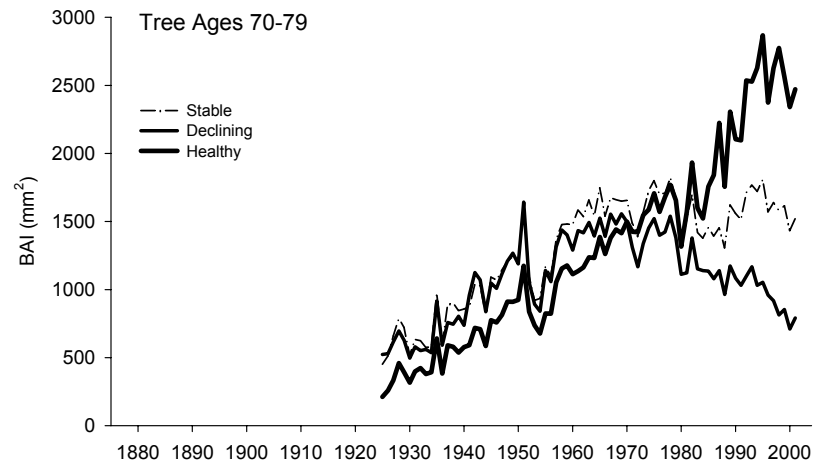
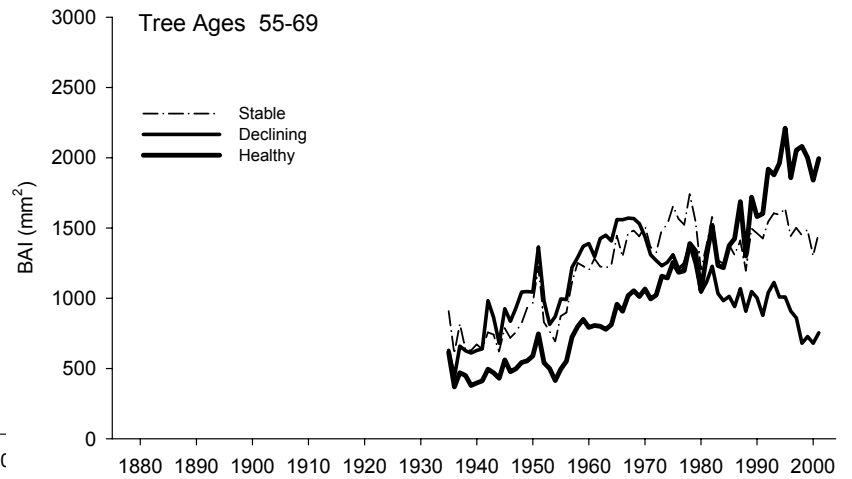
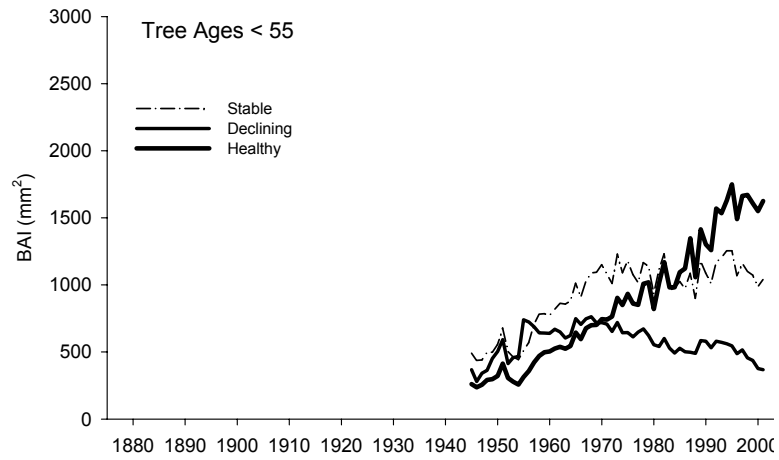
Long-term growth pattern for declining trees.

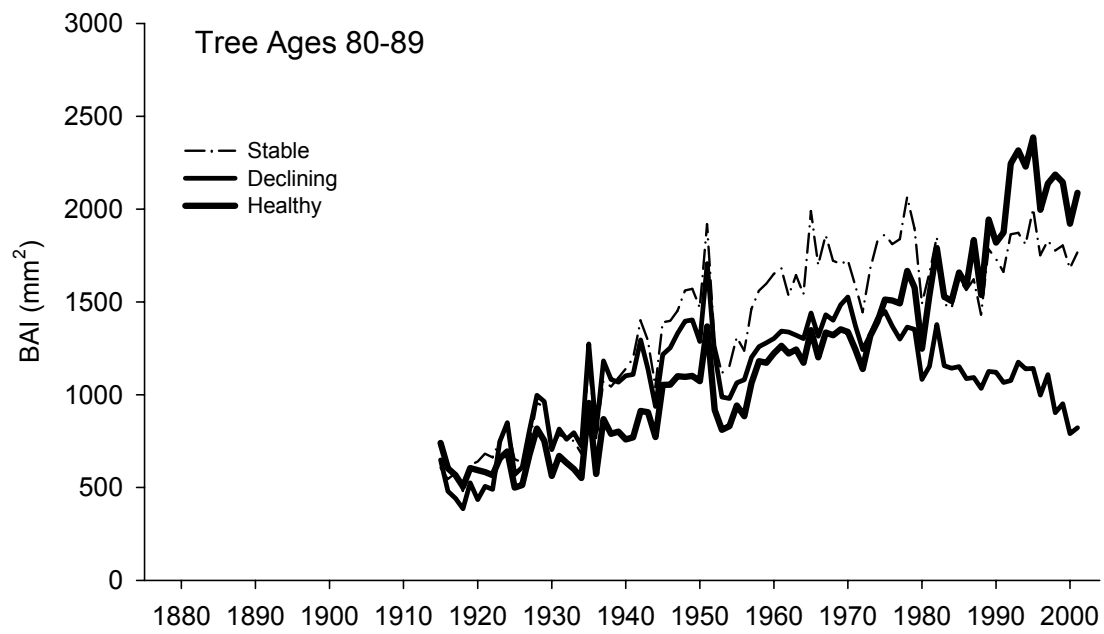


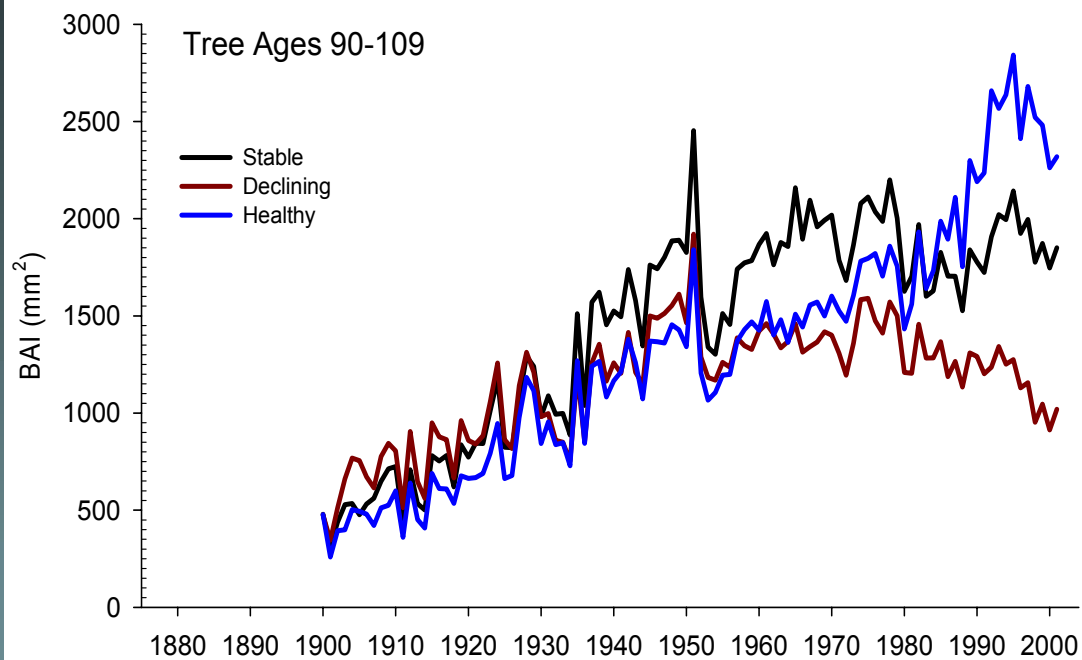
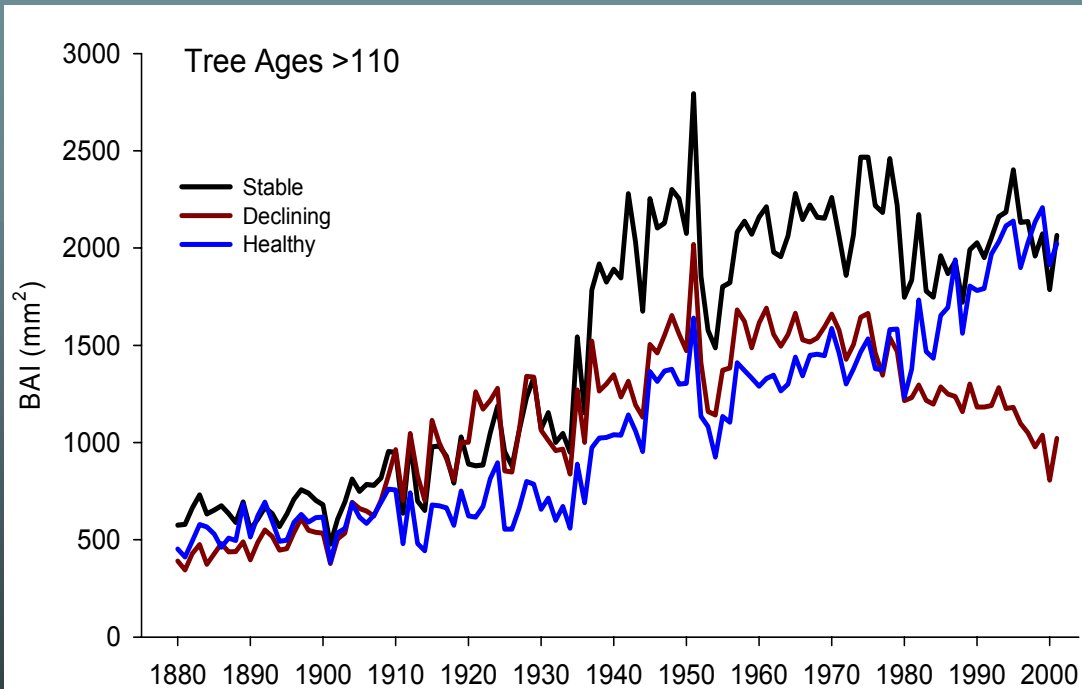
Long-term growth pattern for healthy trees.

Climate-detrended chronologies to isolate long-term trend among dead, healthy and declining red oaks

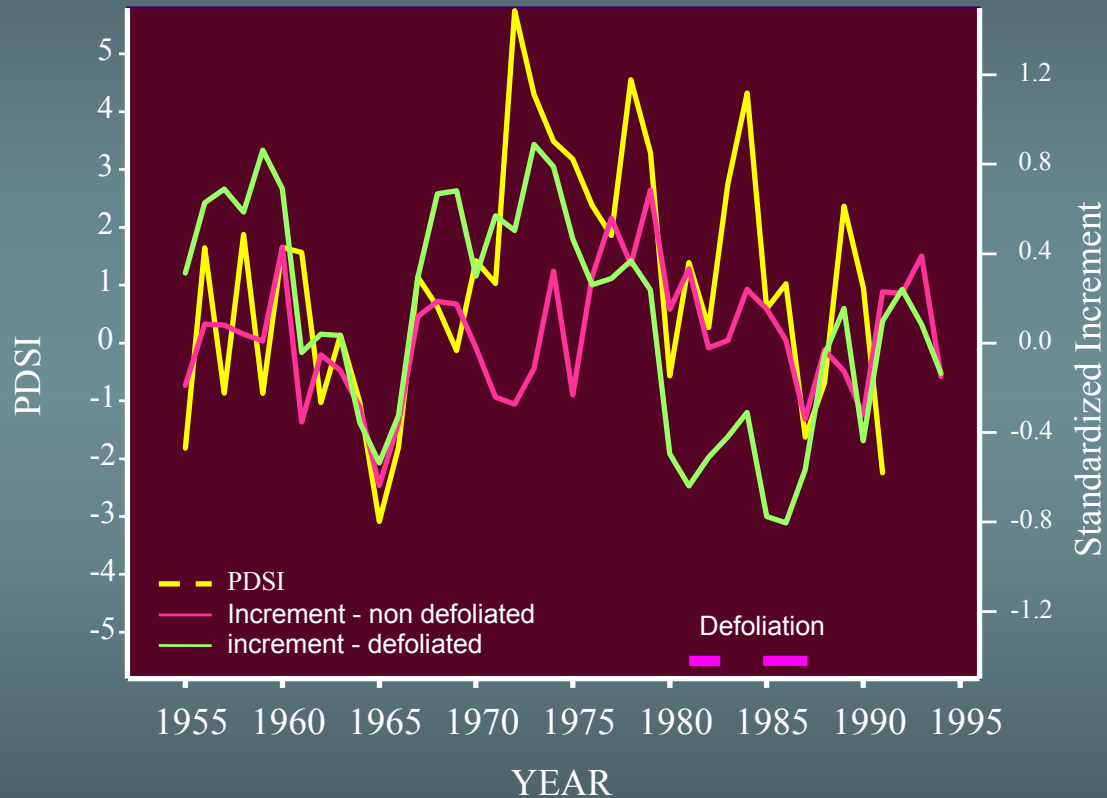






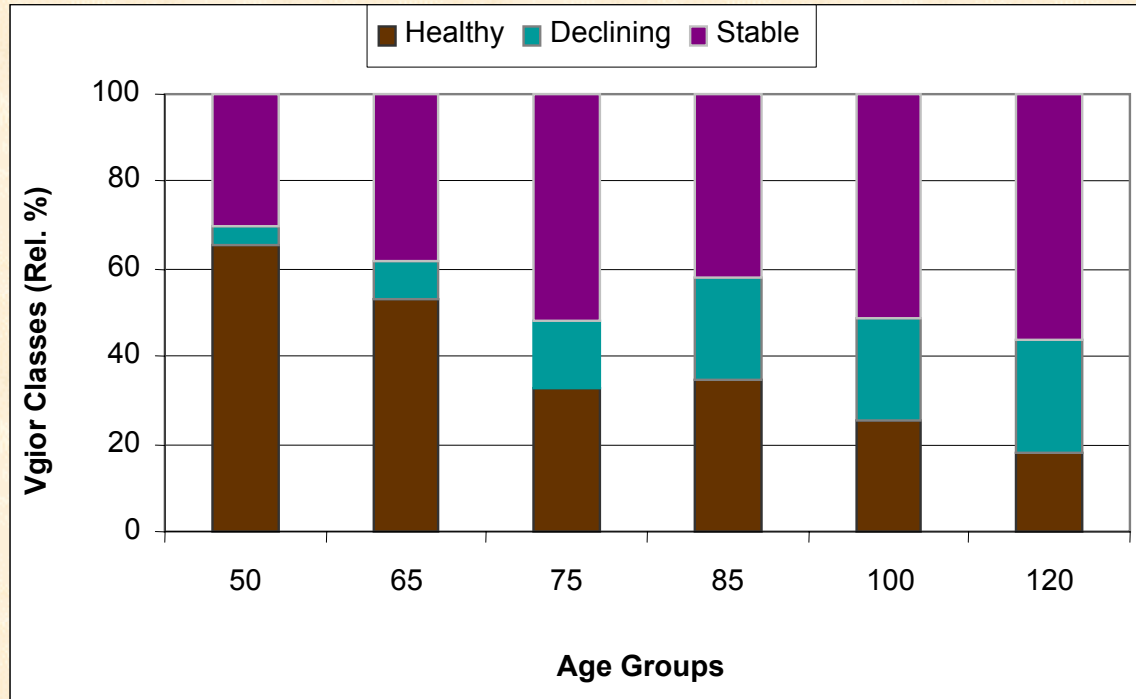


Quercus rubra increment and precipitation



The importance of age

Black Oak



The effect of age

Age Group	50	65	75	85	100	120
<i>Scarlet oak</i>						
Stable	25.3	31.9	41.0	48.3	73.7	71.4
Decline	2.8	7.4	12.7	10.3	7.0	14.3
Increasing	71.9	60.6	46.3	41.4	19.3	14.3
%n / N	33.7	17.8	25.4	11.0	10.8	1.3
<i>Black oak</i>						
Stable	30.6	38.3	51.6	41.7	51.5	56.0
Decline	4.2	8.5	15.5	23.7	23.1	26.2
Increasing	65.3	53.2	32.9	34.5	25.4	17.9
%n / N	18.2	17.8	19.5	17.5	16.4	10.6

Predisposing Factors

➤ Vigor status

➤ Species - Black oak has significantly poorer crown conditions within age groups. Scarlet oak dies at an earlier age when afflicted by decline whereas black oak can persist for many years before death.

➤ Age - The majority of mortality occurs between 60-80, resulting in a stand made up of surviving, larger individuals with low competition for resources and variable stocking levels.

➤ Parent material – decline more common on acidic soils (fire frequency greater and *Armillaria* greater).

➤ Stocking difference mortality due to decline is manifested primarily in average to densely stocked stands at a certain age. After stand structure and stocking changes from mortality, it no longer is a factor.

➤ Site index - Sites with poor to average potential productivity have greater mortality and significantly worse crown conditions

Landform – high mortality on ridges and upper slopes (xeric shoulders)

Identifying 'brood trees'



MOFEP Treatments

An aerial photograph of a forest landscape. The forest is composed of many trees, with varying shades of green and brown. There are several distinct patches of lighter brown and tan color, which appear to be areas where trees have been removed or are in the process of regrowing. These patches are scattered across the forest, with some being larger and more irregular than others. The overall texture of the forest is dense and complex.

Single Tree Selection
Intermediate Harvest (EAM) &
Select Harvest (UAM)

MOFEP Treatments

An aerial photograph of a forest landscape. The top of the image shows a dense, healthy forest with green trees. Below this, a large area of land has been clearcut. The ground is a mix of light brown soil, dark brown logs and branches, and patches of green vegetation. Numerous small, young green trees are scattered throughout the clearcut area, while many dead, grey tree trunks (snags) remain standing. The clearcut area is irregular in shape and covers most of the middle and lower portions of the image.

EAM Clearcuts avg. size = 5 ha

MOFEP Treatments

An aerial photograph of a forest landscape. The forest is composed of many green trees, likely pines, with some areas showing bare ground or dead trees. The terrain appears to be a slope. The text 'MOFEP Treatments' is overlaid at the top, and 'UAM Group Openings avg diameter-> North slope=43m; South slope=21m' is overlaid at the bottom.

UAM Group Openings avg
diameter-> North slope=43m;
South slope=21m



Armillaria

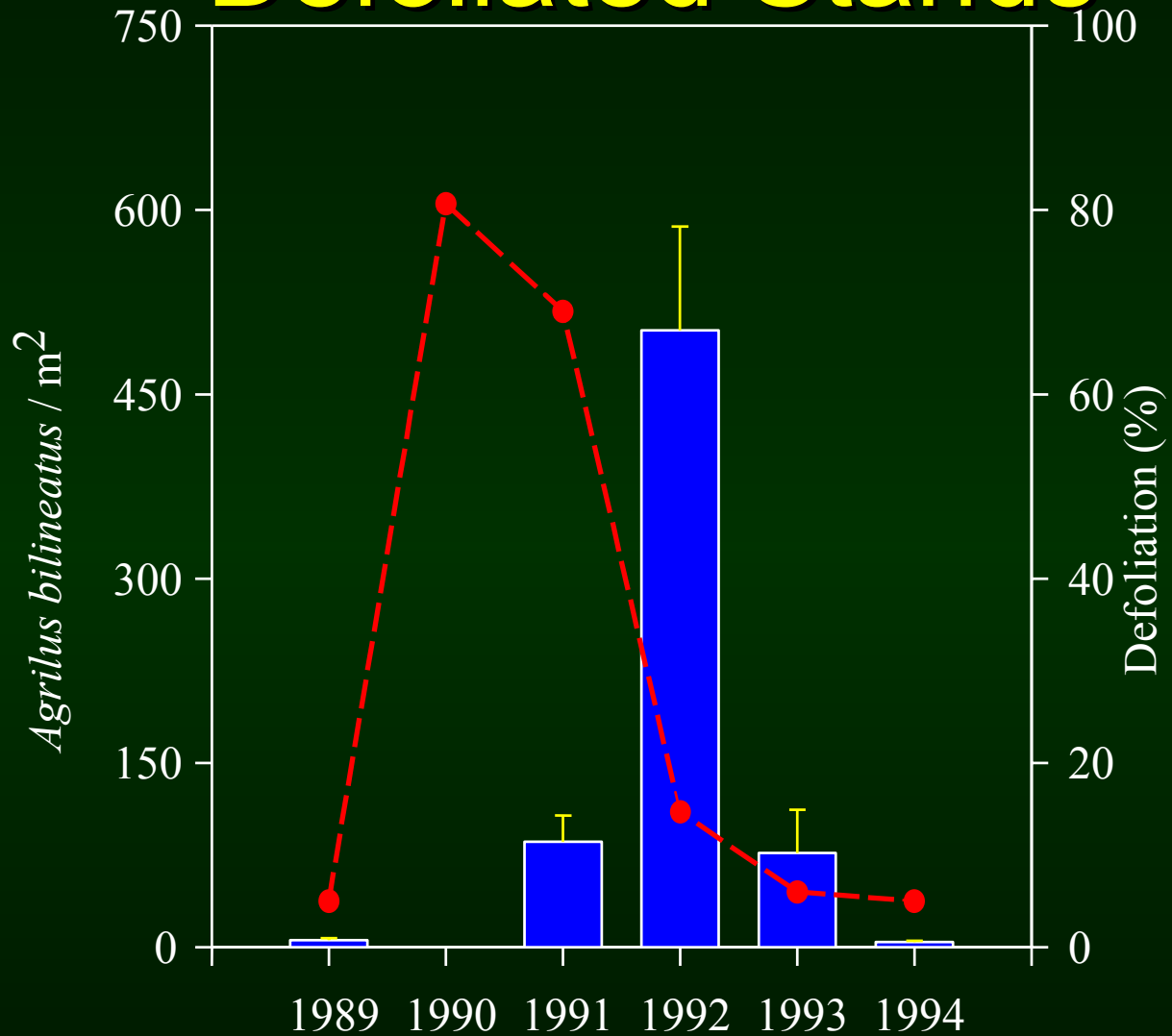
Red oak borer
Enaphalodes rufulus



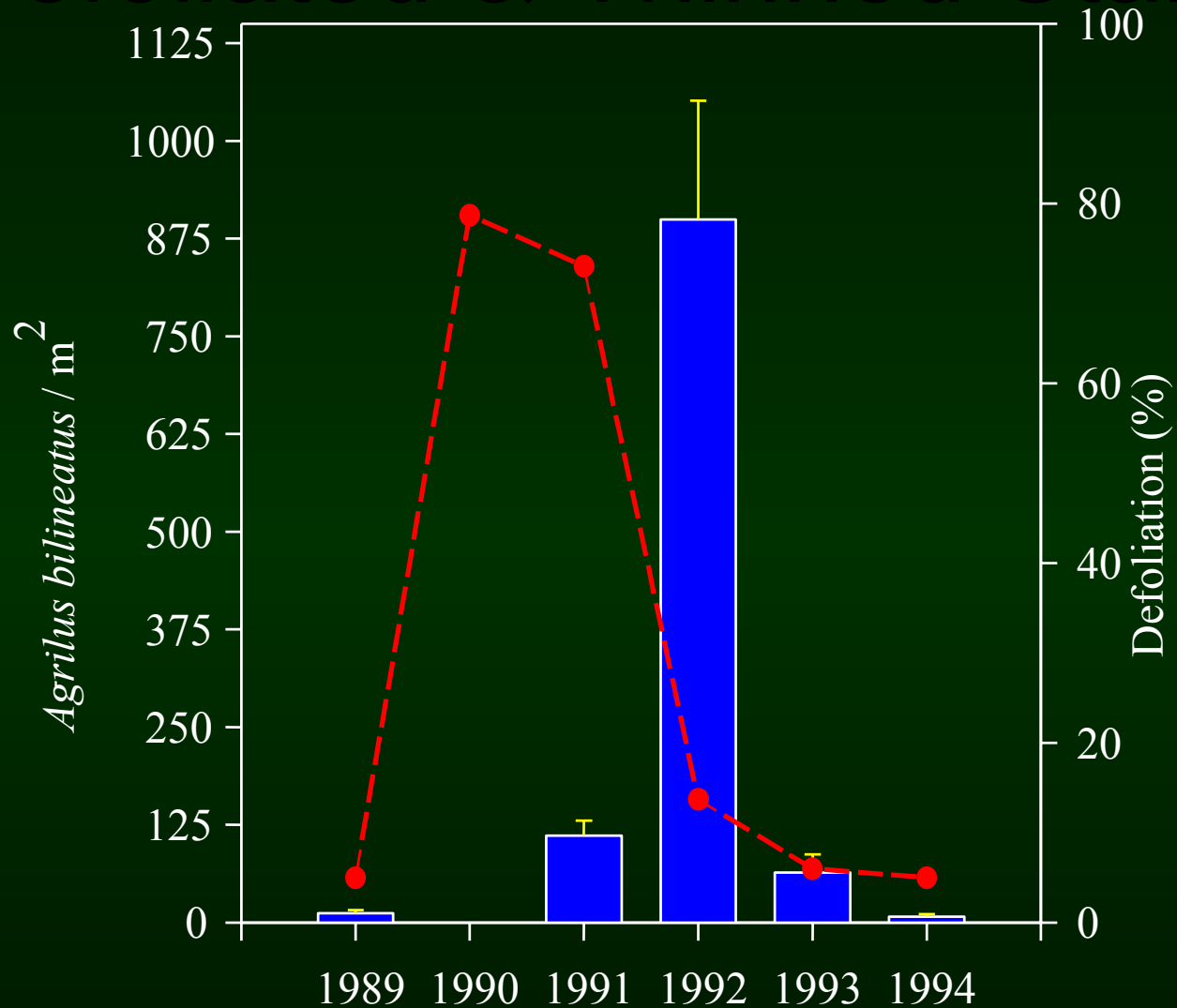
Twolined chestnut borer
Agrilus bilineatus



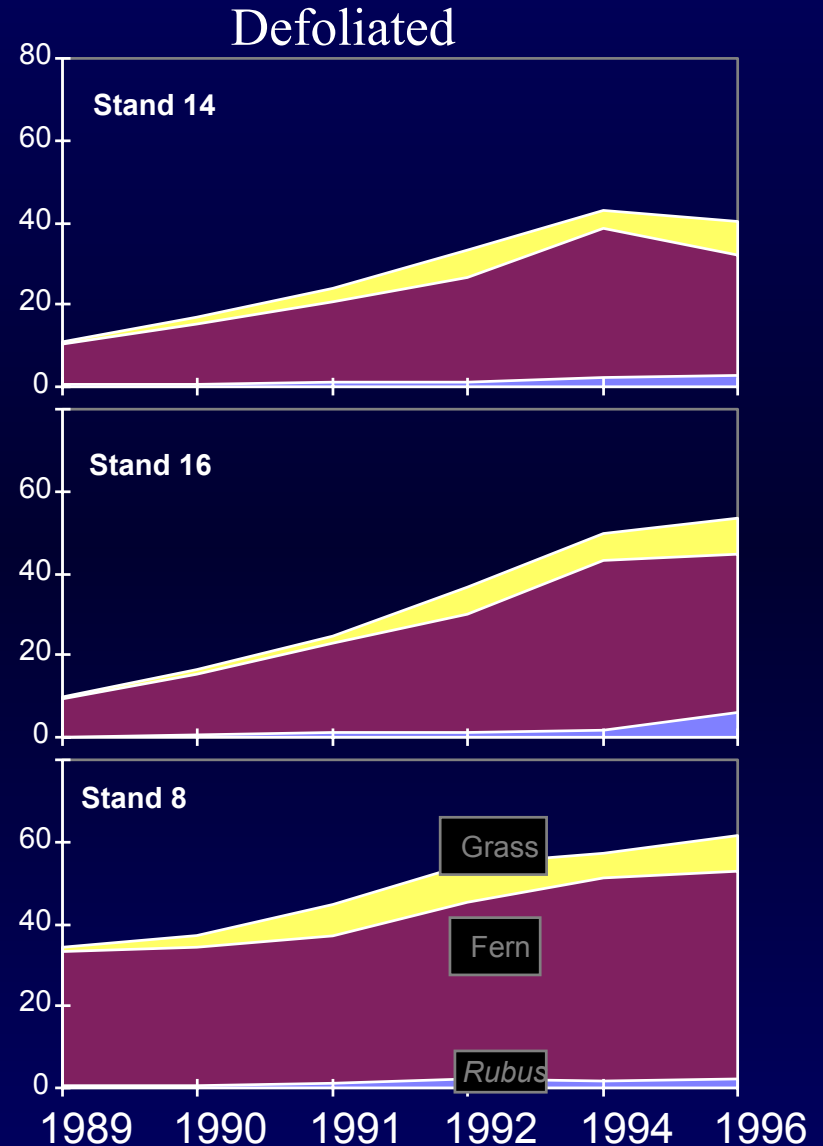
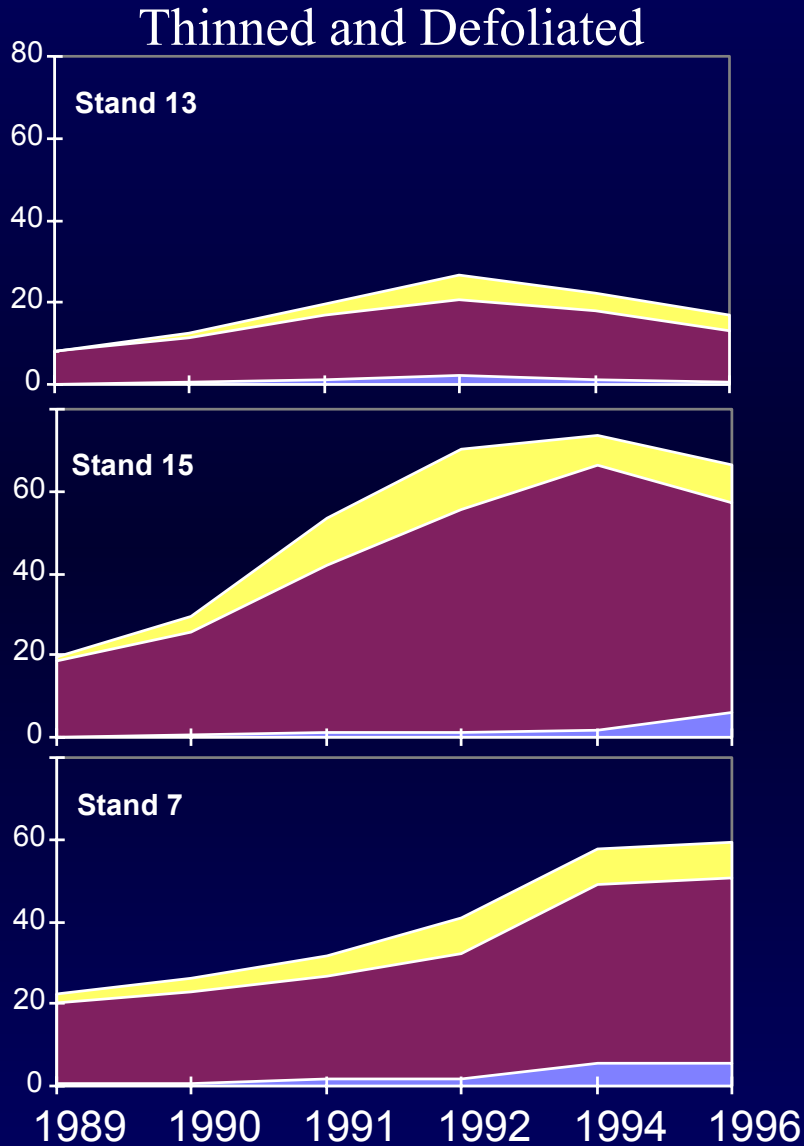
Defoliated Stands



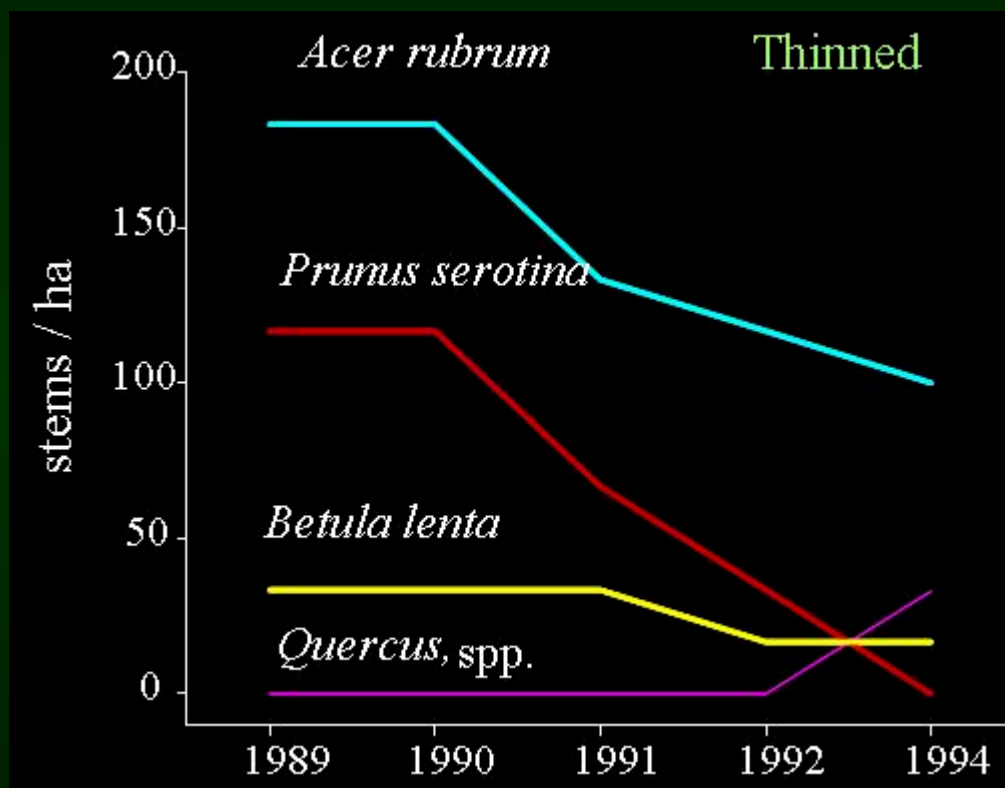
Defoliated & Thinned Stands



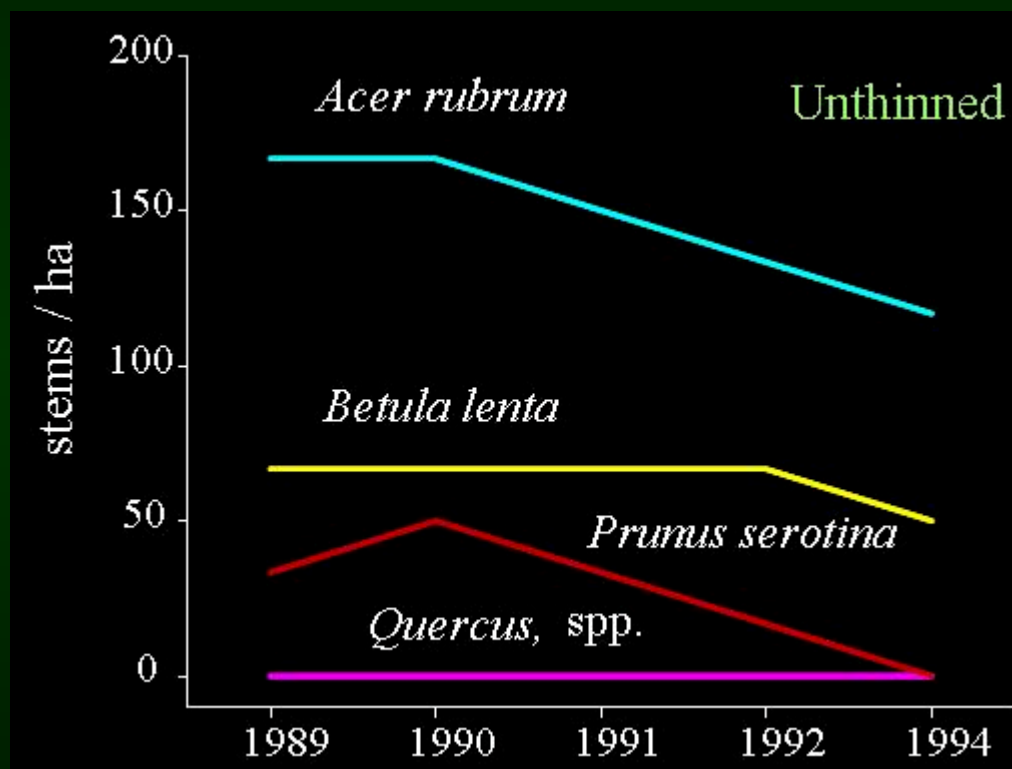
Coverage (%) of Competing Vegetation



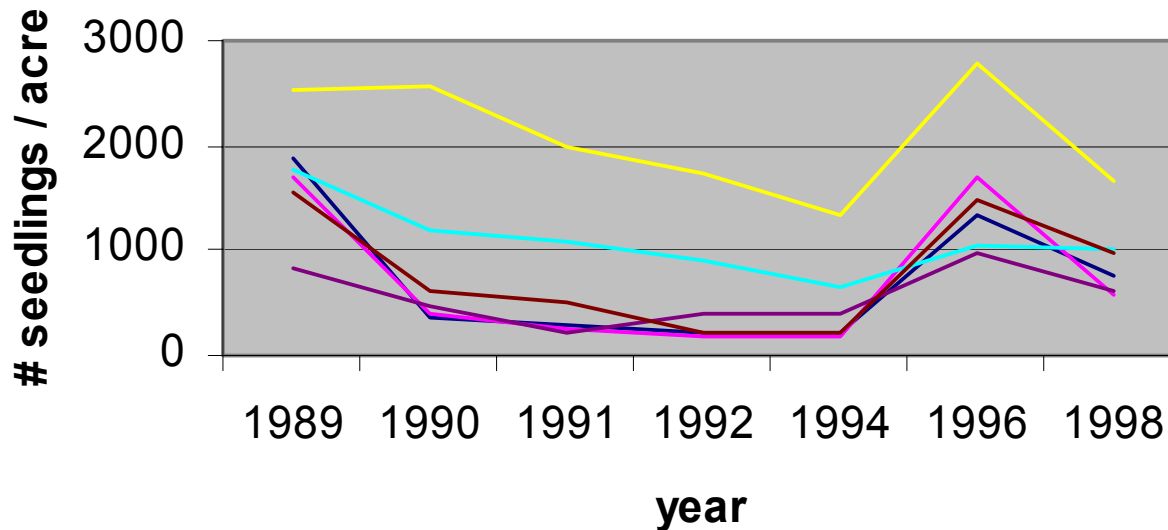
Regenerating Species
> 1.5m tall, <6.3cm dbh
Defoliated – thinned stands



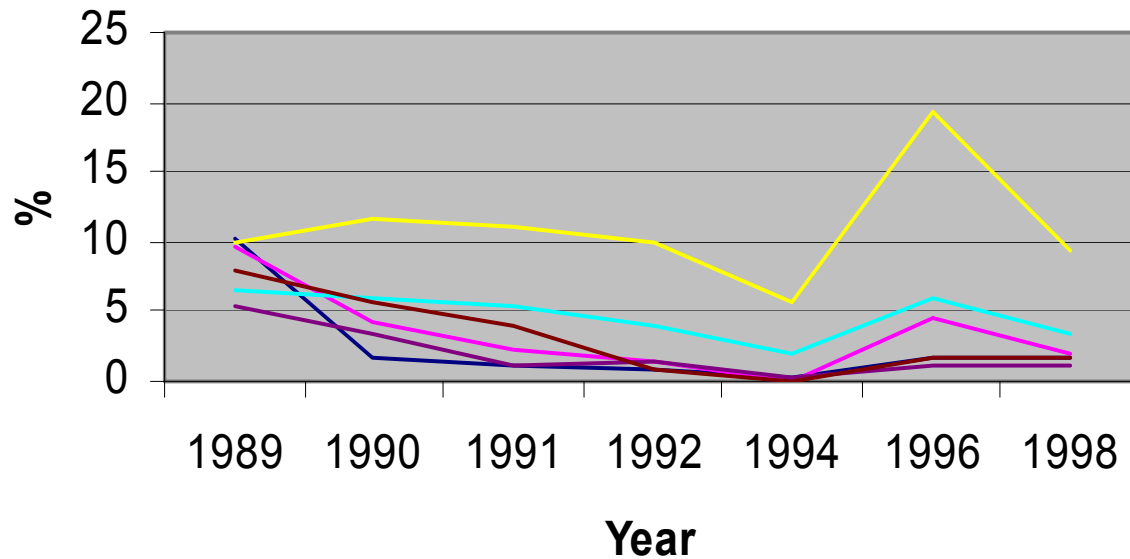
Regenerating Species
> 1.5m tall, <6.3cm dbh
Defoliated – unthinned stands



Total oak seedlings in defoliated stands



Percentage contribution of oak seedlings in defoliated stands

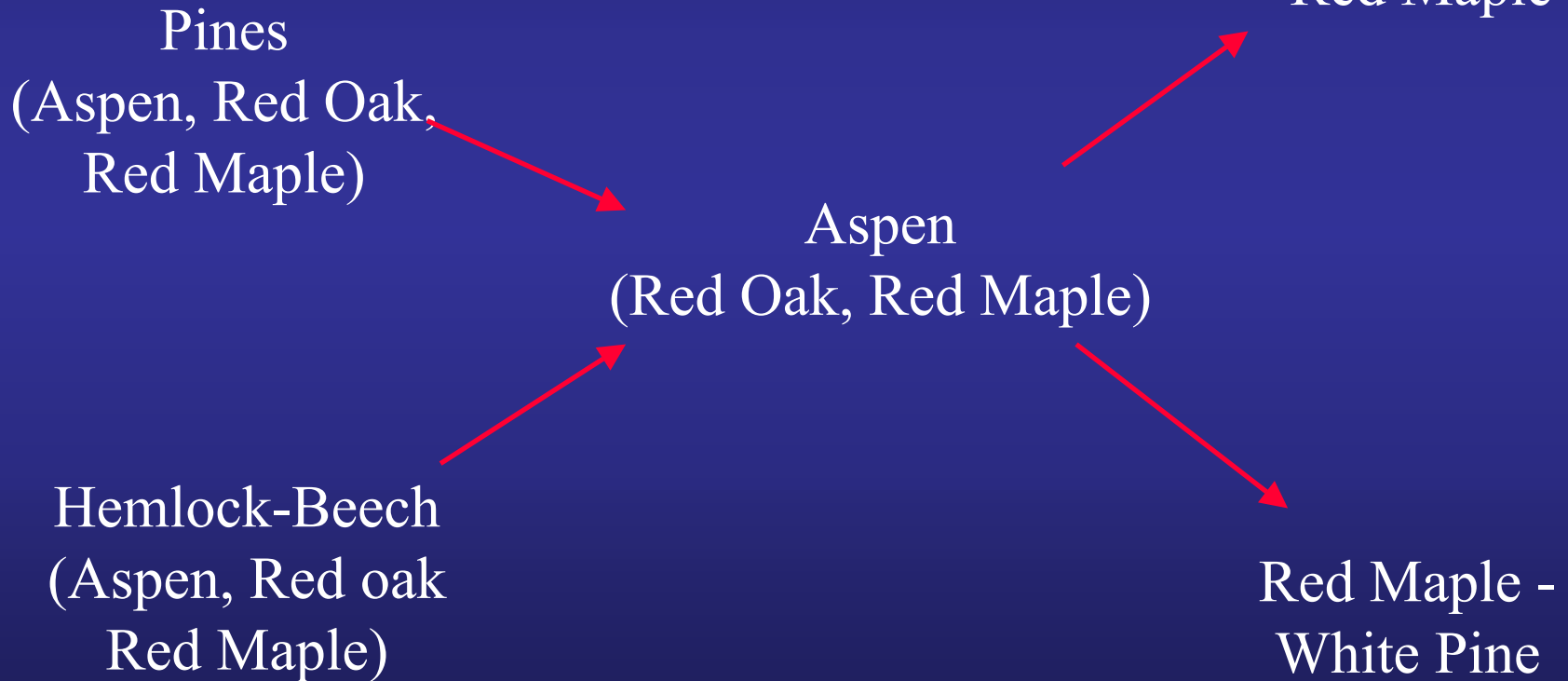


Succession Patterns: forests of northern lower Michigan

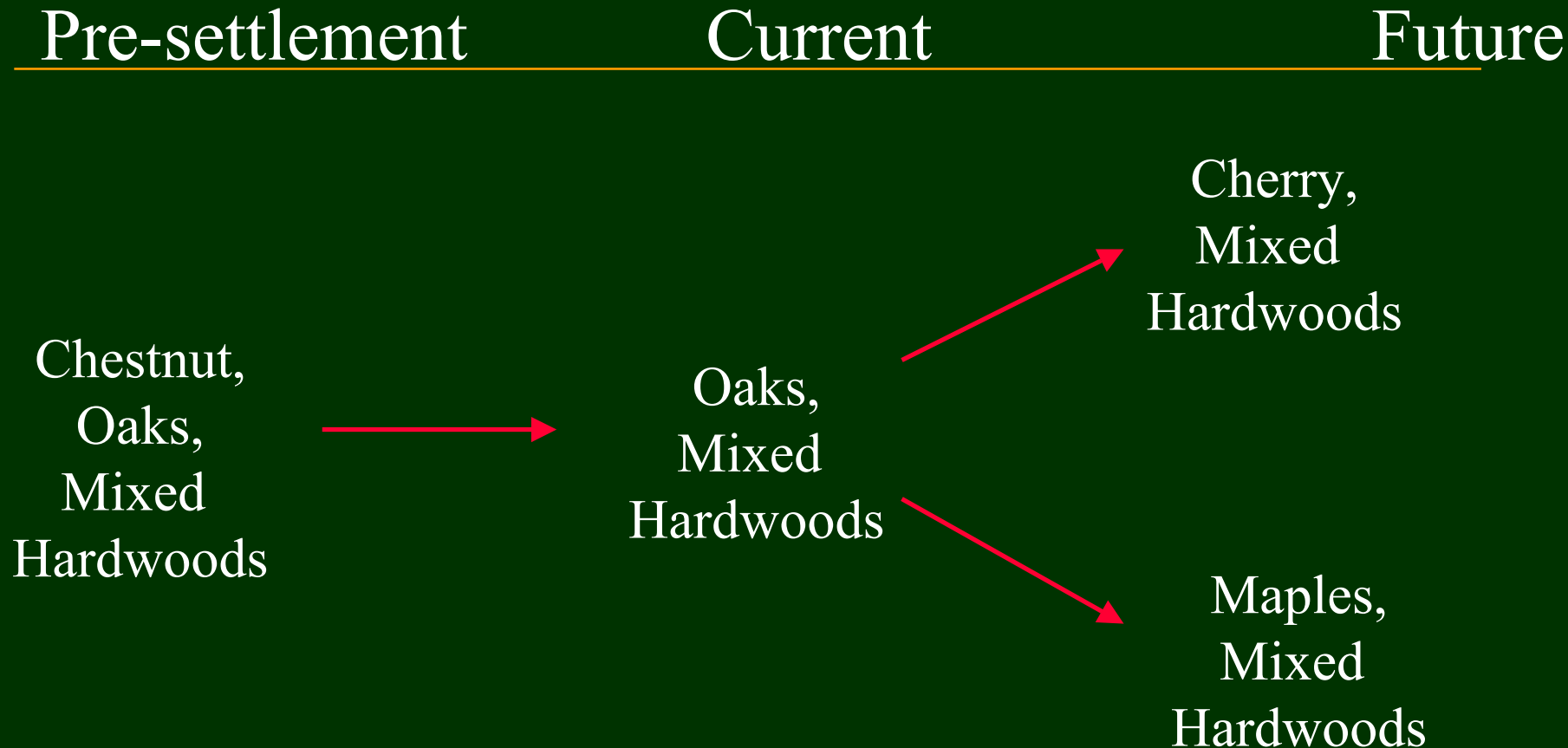
Pre-settlement

Current

Future



Succession Patterns: forests of the Central Appalachians



Succession Patterns: forests of southern New England

Pre-settlement

Current

Future

Northern
Hardwoods
Oaks,
Maples,
Beech



Oaks,
Maples,
Beech,
Birch



Northern
Hardwoods
Beech,
Maples,
Oaks